Nortec® 500 Series Portable Eddy Current Flaw Detectors

Operation Manual

FEBRUARY 2007

PN 7720140.00

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Warranty

The Nortec® 500 Series flaw detectors have been designed and manufactured as high quality instruments.

Inspect the unit thoroughly upon receipt for evidence of external or internal damage that may have occurred during shipment. Notify the carrier making the delivery immediately of any damage, since the carrier is normally liable for damage in shipment. Preserve packing materials, waybills, and other shipping documentation in order to establish damage claims. After notifying the carrier, contact Olympus NDT so that the company may assist in the damage claims and provide replacement equipment, if necessary.

Olympus NDT guarantees the Nortec 500 to be free from defects in materials and workmanship for a period of one year (twelve months) from the date of shipment. This warranty covers only equipment that has been used in a proper manner as described in this instruction manual and that has not been subjected to excessive abuse, attempted unauthorized repair, or modification. DURING THIS WARRANTY PERIOD, Olympus NDT LIABILITY IS STRICTLY LIMITED TO REPAIR OR REPLACEMENT OF A DEFECTIVE UNIT AT ITS OPTION. Olympus NDT does not warrant the Nortec 500 suitability for intended use or fitness for any particular application or purpose. Olympus NDT accepts no liability for consequential or incidental damages including damage to property and/or personal injury. In addition to our standard one year warranty, Olympus NDT also offers an optional two year warranty.

The warranty does not include transducers, transducer cables, batteries, or seals. The customer must maintain the condition of seals in the battery door and office connection doors. The customer will pay shipping expense to the Olympus NDT plant for warranty repair; Olympus NDT will pay for the return of the repaired equipment. For instruments not under warranty, the customer will pay shipping expenses both ways.

In this manual, we have attempted to teach the proper operation of the Nortec 500 consistent with accepted techniques. We believe the procedures and examples given are accurate. However, the information contained herein is intended solely as a teaching aid and should not

be used in any particular application without independent testing and/or verification by the operator or the supervisor. Such independent verification of procedures becomes more important as the criticality of the application increases.

For these reasons, we make no warranty, expressed or implied, that the techniques, examples, or procedures described herein are consistent with industry standards or that they will meet the requirements of any particular application. Olympus NDT expressly disclaims all implied warranties of merchantability and of fitness for any particular application.

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CE

The Nortec® 500 and its accessories have been tested in accordance with EN61326:2002 as required by the EMC directive 2004/108/EC. The Nortec 500 and its accessories meet the emissions requirements of EN61326:2002 for Class "A" equipment and the immunity requirements of EN61326 Annex A:2002.

To ensure compliance to the EMC directive, any cable attached to the USB, VGA, analog I/O, BNC, or probe connectors must be shielded and must be less than three (3) meters in length. Longer cables may be used if installed in conductive cable trays or conduit and may require ferrites.

Warning: Changes or modifications to this instrument or use of unauthorized accessories not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment in countries that require compliance with the EMC directive.

HAZARDOUS AREA OPERATIONS

The Nortec® 500 may be used in potentially explosive atmosphere areas as defined by Class 1, Division 2, Group D of the National Fire Prevention Association Code 70 (NFPA 70), Section 500.

The Nortec 500 and its accessories have been tested to meet requirements in accordance with MIL-STD-810F, Method 511.4, Procedure 1.

Operators of this instrument must understand and be familiar with NFPA 70 and MIL-STD-810F. The instrument must be checked for proper operation prior to entering any hazardous area.

LIMITATIONS OF USE IN HAZARDOUS AREAS

This instrument must be operated from internal batteries, and all external power sources must be disconnected.

Warning: Changes or modification to this instrument or use of unauthorized accessories not expressly approved by Olympus NDT void the user's authority to operate the Nortec 500 in hazardous areas.

1. Nortec® 500 Series Portable Eddy Current Flaw Detectors

1.1 About This Manual

This manual contains information on the three Nortec 500® models: Nortec 500, Nortec 500S, and Nortec 500D. Information applies to all models unless specifically noted in section headers, functions, or applications.

Nortec 500 eddy current flaw detectors incorporate a full range of features: internal balance coils, VGA output connector (for heads up display, monitors, and projectors), and a USB interface for rapid information transfer. The Nortec 500 also includes PowerLink™ for automatic probe recognition and program set-up.

The Nortec 500 is available in three configurations. Each configuration includes digital connectivity and increased resolution with reduced noise. Internal balance coils allow use of absolute probes without the need for external balance coil adapters. A built-in preamp adds extra gain when needed. VGA output allows for the addition of a optional "heads up display" allowing hands free operation. The optional remote-null adapter adds convenience by allowing the probe to be nulled and the instrument screen erased from the probe.

The trans-reflective, monochrome display option and small battery lighten the instrument to 2.8 lbs (1.2 kg) while keeping the full VGA resolution and display size. In situations where rechargeable batteries and AC power are unavailable, a "C" cell battery adaptor can be used. The Nortec 500 can also be powered from a 12 volt vehicle battery.

- The Nortec 500 delivers basic single frequency eddy current inspection including external outputs.
- The Nortec 500S builds on the foundation of the Nortec 500 by adding digital conductivity and coating thickness measurement and the use of rotating scanners.

- The Nortec 500D includes the functionality of the Nortec 500S and adds dual frequency.

1.2 Preparation for Operation

Preparation for operation includes the following topics (discussed below):

- Unpacking the Nortec 500® Series
- Optional Accessories
- Initial Inspection Checklist
- Power Requirements
- Li-Ion Battery Characteristics
- Charging the Li-Ion Battery Pack
- Charger Specifications
- Charger Operation Instructions
- Battery Safety
- Battery Characteristics

1.2.1 Unpacking the Nortec 500 Series

Cartons should be opened and inspected on receipt. The cartons and contents should be inspected for signs of damage. If damage is noted, contact the carrier and retain the damaged shipping materials until an inspection can be performed by a representative of the carrier. Except for the Battery Charger and external accessories, 500 options are installed before the unit is shipped. Check the Packing List to ensure that ordered accessories have been received.

1.2.2 Optional Accessories

The following list includes most 500 accessories. Contact your sales representative for additional information.

Description:	Function:
Probes	Primary sensor for flaw detection, or conductivity measurement
External Null/Erase Adapter	Provides Null/Erase function near probe on Eddy Current instruments
External “Bench top” Li-Ion Battery Charger	Charges batteries outside the instrument
Replacement batteries (2.4Ahr or 8.8Ahr Li-Ion)	Primary power source
Portable printer	Printouts and reports
Probe Adapters	Provides means to connect other manufacturer’s probes to this eddy current instrument.

1.2.3 Initial Inspection Checklist

After the Nortec 500 has been unpacked and the contents of the carton have been checked against the packing list, a visual inspection and basic operation test should be performed.

- Cosmetic or structural damage?
- Instrument power ON? When the instrument powers up, it is normal operation for random lines or colors to be displayed for up to ten (10) seconds until the instrument display drivers have had time to load.
- Display Sign On Message displays?

1.2.4 Power Requirements

As a fully portable inspection instrument, the Nortec® 500 relies on one Li-Ion battery as the primary source of power. The battery compartment is located at the rear of the unit and is conveniently accessed by loosening the four quick release screws and removing the battery cover.

The Li-Ion battery pack provided with the Nortec® 500 instrument is small, lightweight, portable, and capable of delivering long service life between recharges or battery replacement. Replacement batteries are available through the factory or authorized retailer.

The Battery Charger is provided with the Nortec® 500 for recharging the Li-Ion battery pack while in the instrument and allowing the Nortec® 500 to be operated from AC line power. The charger unit auto senses 100 to 240 volts AC line power at 47 to 63 Hz.

The condition of the batteries used in the Nortec® 500 is monitored by the charger. Fully discharged Li-Ion batteries will require approximately 6 hours. The charger will not charge

batteries which are too hot, too cold or too deeply discharged.

Note: Fully charge the battery before first use. Instrument run time is affected by variables such as: quality of charge, age of battery, and display type. The battery charge indicator on the display is an estimation of expected run time. Instruments are equipped with a circuit that shuts off power prior to full discharge. Battery life is affected by: number of charge/discharge cycles, storage conditions, temperature, and use. Batteries stored for extended periods of time (months/years) without use may no longer recharge. Under normal use a Lithium-Ion battery will last approximately 300 cycles. Expect to change the batteries after 1 year of heavy use or 3 years of light use under normal conditions. Batteries must be disposed of in accordance to local law or returned to Olympus NDT. Olympus NDT does not warranty batteries due to operating conditions beyond the company's control affecting battery life.

For Optimum Performance

- Upon first use, or after prolonged periods of storage, you may need to charge and discharge your battery two or three times before obtaining optimum performance.
- It is best to charge the battery at room temperature ranging between 59°F (15°C) and 86°F (30°C).
- It is normal for the battery to become warm during charging or after use.
- It is not necessary to fully discharge your battery before charging. You can top-off the charge at any time.
- A charged battery will gradually lose its charge if left in storage. We therefore suggest that you top-off the charge before use.

Safety Precautions

- Do not disassemble or attempt to open the battery under any circumstances.
- The battery can explode, leak, or catch on fire if heated or exposed to fire or high temperatures.
- Do not short circuit the battery by directly connecting the metal terminals (+, -). Be certain that no metal objects such as coins, paper clips, etc., touch the terminals.

Use only a battery charger supplied from the instrument manufacturer or one that meets manufacturer specifications.

To Avoid Damage to the Battery

- Do not drop the battery or subject it to mechanical shock.
- Use the battery only with equipment that specifies its use.

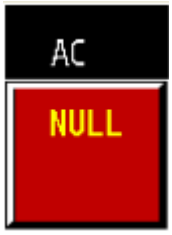
1.2.5 Li-Ion Battery Characteristics

- Higher capacity — up to 60% longer run time than ordinary Ni-MH batteries of equivalent size
- Fast Charge — approximately 6 hours
- Long cycle life — up to 300 charge/discharge cycles
- Temperature Range (charging) — 32°F to 104°F (0°C to 40°C)
- Temperature Range (operating) — -4°F to 140°F (-20°C to 60°C)
- Temperature Range (storage) — -4°F to 122°F (-20°C to 50°C)
- Environmental friendliness — 0% cadmium, no disposal problems
- Size L x W x H — 8.5 x 2.3 x 0.9 in. (215 x 59 x 23 mm)
- Weight — 17.6 oz. (493 g)
- Nominal Voltage — 10.8V
- Rated capacity — 2.4 Ah or 8.8 Ah nominal
- Hours of Operation — 6+ hours with monochrome or color LCD display

1.2.6 Charging the Li-Ion Battery Pack

Proper charging of the Li-Ion battery packs is critical for overall life and performance. The Battery Charger will charge either the Li-Ion battery in the instrument or the charger also functions as a battery eliminator to operate the instrument from the AC power source. Batteries do not have to be installed to operate the instrument from AC.

When operated from the charger without a battery installed in the instrument the battery “Gas Gauge” will not display. Instead the “AC” icon will be displayed alone indicating the battery is not present as indicated in the figure below.



Note: If the battery is not seated correctly in the battery compartment and not charging or if the battery is faulty the battery “Gas Gauge” will not be present above the “AC” icon. Re-check the positioning of the battery or replace the faulty battery and the “Gas Gauge” will then appear.

The instrument can be operated while a Li-Ion battery is being charged, but it is not recommended to charge the Li-Ion battery and operate rotary scanners at the same time.

1.2.7 Charger Specifications

- Power Requirements: 85 to 240 volts, 50 to 60 Hz
- Positive (+) center connection.
- Diameter of connector: 2.5 mm.
- The charger contains internal current limiting circuitry.
- The Charger charges one Li-Ion battery at approximately 1.5 ampere rate. An 8.8 Ahr battery charges in approximately 6 hours.
- Temperature range: Batteries should be charged between 40° to 100° F (4° to 38° C) for best results.
- If the batteries become too hot, the battery charger will terminate the charging process.
- To start a charge cycle, the charger can be reset by disconnecting and reconnecting either the instrument or AC power to the battery charger.

1.2.8 Charger Operation Instructions

- Connect the charger to a source of AC power. Connect the charger to the Nortec® 500. The red charging indicator on the Nortec® 500 will light, indicating that the batteries are charging and the “AC” icon will be shown below the battery “Gas Gauge”. The LED

indicator will turn green when the battery is charged and the “AC” icon will remain on until the battery charger is removed.

- During use, the charger case will become warm.
- The charger is designed to shut off after a Li-Ion battery is fully charged (the instrument power is always available). It does not provide a maintenance charge, because Li-Ion batteries can be damaged by trickle charging.
- Li-Ion batteries have a long shelf life and should only require recharging after many months of storage if not used.

1.2.9 Battery Safety

Old batteries that will no longer deliver satisfactory service should be disposed of in a legal and environmentally friendly manner. If there is no convenient battery recycle center, the batteries may be returned to Olympus NDT for proper disposal.

No battery should be disposed of by fire or abused by puncturing its case or disassembled. All batteries contain potentially hazardous chemicals however Li-Ion batteries do not contain lead, cadmium or mercury.

Lithium-Ion batteries contain an internal safety circuit. Lithium-Ion batteries contain internal fuses. If the fuse blows or the safety circuit shuts off the battery, the battery is no longer fit for service. The internal safety circuits are not serviceable.

Olympus NDT purchases batteries from reputable vendors. Although Olympus NDT tests and qualifies the batteries for use in products, Olympus NDT cannot guarantee that batteries obtained from other sources will be satisfactory or that Olympus NDT supplied batteries will work in non-Olympus NDT products.

1.2.10 Battery Characteristics

Most batteries will not deliver their full charge on first use or after extended storage. Use them until the instrument shuts off after full discharge (automatic low battery shut off) and recharge. This will recondition the battery.

The battery is considered by the manufacturer to be beyond its service life when it delivers less than 80% of its rated capacity. Li-ion batteries should have a life expectancy of 300 charge/discharge cycles. These specifications are obtained under laboratory conditions and real world usage will be different. Battery life will be prolonged if batteries are not subjected to harsh temperatures, either hot or cold, and are stored in a charged condition.

Batteries have reduced capacity at low temperatures. Exact percentages are not specified but

operation below freezing is not recommended. Newer versions of Li-Ion batteries, also known as "SMBus Smart Batteries," have a microprocessor built into them that monitors the batteries usage and displays the condition on a gas gage in the battery. It is possible to accumulate errors over time due to temperature extremes, aging, self discharge, and other factors.

The gas gauge on the battery and the gas gauge on the instrument front panel display the same information from the SMBus Smart Battery internal microprocessor.

The optional Li-Ion external “bench top” charger has a "recalibration" feature that charges, discharges, recharges, and stores updated information in the microprocessor within the "SMB" capable batteries. This process is only needed when the gas gage in the battery does not show the proper information.

Examples of a battery requiring recalibration are; after running the instrument for a short time and the battery gas gage has one or no bars showing or when fully charged, the gas gage has four or less bars showing. Refer to the instructions provided with the external charger for proper operation and usage.

Note: (Nortec® 500S and Nortec 500D Only) Scanners draw enough current from the batteries to significantly shorten battery life and operation of the instrument. Loading a scanner can activate the automatic low battery shutoff circuit when the batteries are nearly discharged.

Operating Environment

The Nortec 500 is designed as a portable instrument and, as such, requires no special site preparation before operation. When operating, the instrument should be firmly supported to prevent damage due to a fall. The unit is manufactured to meet IP65 specification but should be protected as much as possible from water or chemical splashes, rapid temperature changes, and should be operated away from large electrical equipment that may interfere with the operation of internal circuitry.

Note: The test instrument and reference standard should be allowed to stabilize to the same temperature as the parts or material to be tested. To check for temperature drift, take several readings at timed intervals until the values have stabilized. Always check the calibration before taking a reading. A 15 minute warm up period before calibration is recommended.

Note: Poor quality or excessively long cable, while not detrimental to the instrument, can adversely affect signal-to-noise ratio. For best results, use quality cables no longer than necessary for the operation.

2. Nortec® 500 Series Technical Data

What's in this section? Nortec 500 Series Technical Specifications

Basic Performance

Frequency Range	50 Hz -12 MHz
Gain	0 - 90.0 dB
Sensitivity	Adjustable to 200 volts/ohm
Flaw Response	0 - 2000 Hz (nominal)
Digitizing Rate	6000 samples/sec (max)
Rotation Variable	0° - 360° in 1° steps
Sweep Variable	0.005 - 4 seconds/division
Low Pass Filter	10 Hz - 500 Hz in 1 Hz increments, 500 Hz - 2000 Hz in 50 Hz increments, Wb setting of 4 kHz. Greater than 4 pole response.
High Pass Filter	0(dc), 2, 4, 6, 8, and 10 - 500 Hz in 1 Hz increments. Two pole response available infrequency 1 only.
Probe Drive	Adjustable in three steps (low, medium, high) corresponding to 2, 6, and 12 V peak to peak into 75 ohms, ± 0.5 V.
Null	Three stage digital null.
Variable Persistence	Screen persistence varies 0.1 - 5 seconds in 0.1 steps. Operator may select periodic screen erase at intervals of up to 1 minute. Basic stored screen time is infinite with manual erase.
Probe Types	Absolute and differential in either bridge or reflection configuration, I.D., O.D., bolt-hole, Sliding, and custom special product orders (SPO).

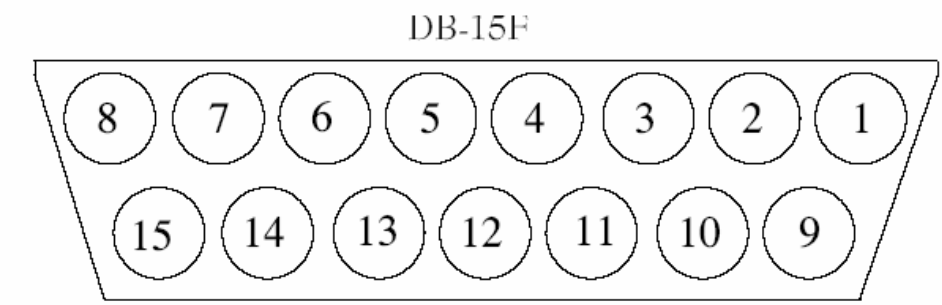
Scanner Drive	Drives PS-5AL, MiniMite, Spitfire 2000, or RA2000 scanners at the following speeds (Nortec 500S and Nortec 500D Only): PS-5AL - 40 - 240 rpm MiniMite - 600 - 3000 rpm Spitfire 2000 - 600-3000 rpm RA2000 - 600 - 2400 rpm
Alarms	Can be set to trigger when signal enters the alarm area or is outside alarm area.
Alarm Modes	Impedance Plane Display. 1 to 3 independent box gates, one polar gate. Sweep display - high and low threshold gates (Nortec 500S and Nortec 500D models only).
Waterfall Display	4 - 60 lines with 32 lines maximum display simultaneously. 105 - 210points/sweep recorded (Nortec 500S and Nortec 500D models only).
Conductivity Accuracy	±0.5% IACS accuracy from 0.9%-62% IACS ±1.0% IACS accuracy over 62%. Liftoff accuracy from 0-15 mil ±1 mil. Conductivity measurements with greater than 10 mil of liftoff have reduced accuracy (Nortec 500S and Nortec 500D models only).
Non-conductive Coating Thickness	Measures non-conductive coating thickness from 0.00”-0.025”. Coating accuracy ±0.001” over 0.00-0.015” thickness (Nortec 500S and Nortec 500D models only).
Trace Storage	Stores up to 200 traces for recall. Locations may store any combination of frozen screens or movement of the impedance spot for up to 60 seconds.
Program Storage	Instrument setups may be stored and recalled. The date and time of storage are recorded and available to the operator. Each location may be labeled with alphanumeric names up to 29 characters. The instrument can maintain storage up to two days with batteries removed. It is suggested that instrument data be backed up to a PC if the instrument is to be placed in storage for extended periods. This can be accomplished via the included EddyMaster 500 software.

Serial Interface	USB “On-The-Go” (OTG) compatible serial interface communicates with external computer or USB printer. Instrument parameters except power ON/OFF can be controlled through the serial interface. All programs and stored screen locations are accessible through this interface.
Printout	Printout available with optional USB printer. Printout text may be customized from either the front panel of the N500 or an external computer.
Supported Printers	Pentax Pocket Jet 3 or HP USB.

Inputs/Outputs (All models)

Power	2-pin connector to operate from AC power and charge internal batteries.
USB Connector	For bidirectional serial data by way of USB OTG. Links to external computers, terminals, or printers.
Outputs	DB15F connector provides analog out for vertical and horizontal signals (±5 v, 10 mA max. 1v per div.) on both Frequency 1 and Frequency 2 and 5VTL compatible (3v logic) active high alarm output.
Probe Connectors	16 pin LEMO and single BNC connector.

Nortec® 500 Auxiliary Outputs (View into Pins)



Pin and Eddy Current

- 1 Ground
- 2 Frequency #1 Vertical
- 3 Frequency #1 Horizontal
- 4 Frequency #2 Vertical
- 5 Frequency #2 Horizontal
- 6 Mixed Vertical
- 7 Mixed Horizontal
- 8 Ground
- 9 #1 alarm (box 1)
- 10 #2 alarm (box 2)
- 11 #3 alarm (box 3)
- 12 Polar or sweep alarms
- 13 Lock on
- 14 + Battery voltage (relays)
- 15 Special

The RF and video outputs have adjacent pin grounds. Pin15 is tied to an internal wire point for SPO's. The instrument auxiliary is a standard density 15 pin D female connector.

Additional Features

Reports Field	User defined 38-character report header, up to 7 user defined 40-character report fields and 26 character labels, up to 3 user defined 26-character report entries may be download to the USB port or entered through the report edit function. Clock, calendar time, date stored and printed with each waveform. Instrument ID, manufactures name, and model printed with each waveform (PowerLink™ probes only). International menu selectable languages including English, Spanish, French, and German.
Conductivity (Nortec® 500S and Nortec 500D Only)	Frequency: 60 kHz or 480 kHz Probe Type: Conductivity Probe Digital Conductivity: Digital conductivity display from 0.9%-110% IACS. Accuracy within ±0.5% IACS from 0.9%-62% IACS and within ±1.0% of values over 62%. Meets or exceeds BAC 5651. Conductivity measurements with greater than 10 mils of lift-off have reduced accuracy. Alarms: Independent high and low limit alarms can be set for conductivity lift-off. Alarms can be set to trigger when the signals are inside the limits or outside the limits.
Dual Frequency (Nortec 500S and Nortec 500D Only)	Second Frequency: 100 Hz - 3 MHz, 2nd frequency is an exact division of the first frequency in rations of 1/2 (F1<6 MHz), 1/4, and even divisors to 1/32. Display: Frequency 1 only, Frequency 2 only, sum of frequencies 1 and 2, difference between frequencies 1 and 2, split screen with selected combinations of frequencies 1 and 2 and mixed frequencies.

General

Dimensions	9.5” L x 5.5” W x 3.6” D (241 mm x 140 mm x 92 mm)
Weight	2.8 lbs with 2.4 Ahr battery and 3.8 lbs with 8.8 Ahr battery
Display	5.25” x 3.9”, 6.5” diagonal (133 mm x 99 mm, 165 mm) full VGA color LCD (640 x 480 pixels)
Operating Temperature	14° to 131ºF (-10º to 55ºC)

Storage Temperature	60º to 160ºF (-51º to 71ºC)
Power DC	One 8.8 Ahr Li-Ion or one 2.4 Ahr Li-Ion battery
Power AC	External charger/adapter. Fully charges batteries in approximately 6 hours. Line voltage 85-240 VAC, 50-60 Hz.
Low Battery	Display bar graph “gas gauge” indicates approximate operating time. A low battery annunciator indicates when approximately 10 minutes of operation time is left.
Operating Time	3 to 8 hours depending on battery configuration and scanner usage.
Humidity	MIL-STD-28800-Safe operation in exposure to Class 3 temperature/humidity environment (-10°C-55°C @95% ±5% relative humidity, non-condensing).
Altitude	Maximum operating and non operating altitude 15,000 ft. (4600 m).
Hazardous Area Operation	Safe operation as defined by Class I, Division 2, Group D, as found in the National Fire Association Code (NFPA70), Section 500, and tested using MIL-STD-810F, Method 511.4, Procedure 1
Ingress Protection	Designed (not tested) to withstand environments to IP-65.

3. Nortec® 500 Series Control Descriptions

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- 3.16 Waterfall Display Function
- 3.17 Conductivity Mode
- 3.18 Preamplifier

3.1 PowerLink™ Operation

The PowerLink™ feature enables the Nortec® 500 instrument to recognize Nortec PowerLink™ probes and scanners, configuring the instrument according to the parameters programmed into the ID chip. Each PowerLink™ probe is programmed at the factory to

identify itself by model number, pre-selected operating frequency, and serial number.

The PowerLink™ connection is automatically made when a PowerLink™ probe is connected into the Nortec® 500 instrument. When the PowerLink™ probe is connected to the instrument the screen displays:

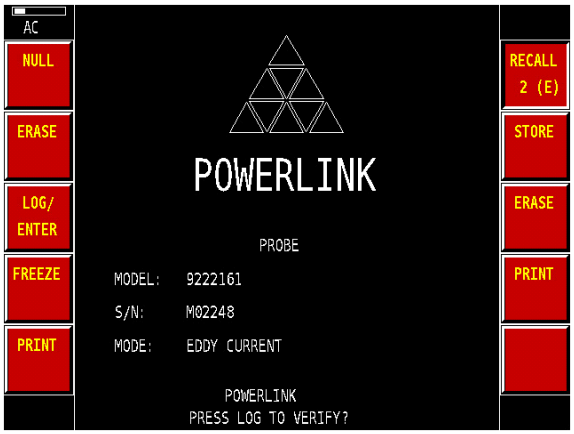
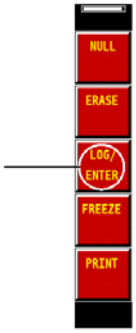


Figure 3.1: PowerLink™ Detection Screen

To proceed without using the PowerLink™ feature, press the MAIN function key twice.

To use the PowerLink feature, press the LOG/ENTER soft key to download information.



After pressing the LOG/ENTER soft key the display refreshes and displays the following information:

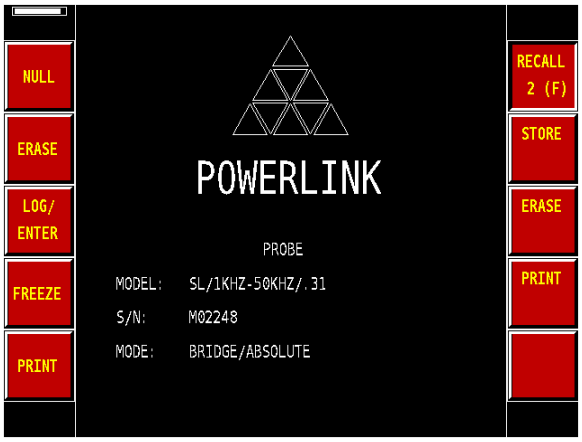


Figure 3.2: PowerLink™ Completed Screen

After the PowerLink™ program is downloaded to the instrument you may recall any other program stored using this probe which is determined by the probe serial number. To do this press the RECALL soft key and rotate the SmartKnob™ until the desired program number is shown and press the RECALL soft key.

PowerLink™ probes can also be programmed for Level II commands, and any of the instrument parameter commands can be pre-loaded at the factory to fully set up the desired test.

Level III PowerLink™ programming (user programmable) is supported by using a Nortec® WorkStation or PowerStation. Level III programming allows the user to program the ID chip to meet their specific needs. Large chip data capacity allows for a chip to be reprogrammed if the need arises. For every probe, PowerLink™ can be bypassed to allow the probe to be used for any applicable test.

3.2 Instrument Controls

Instrument controls are displayed bellow:

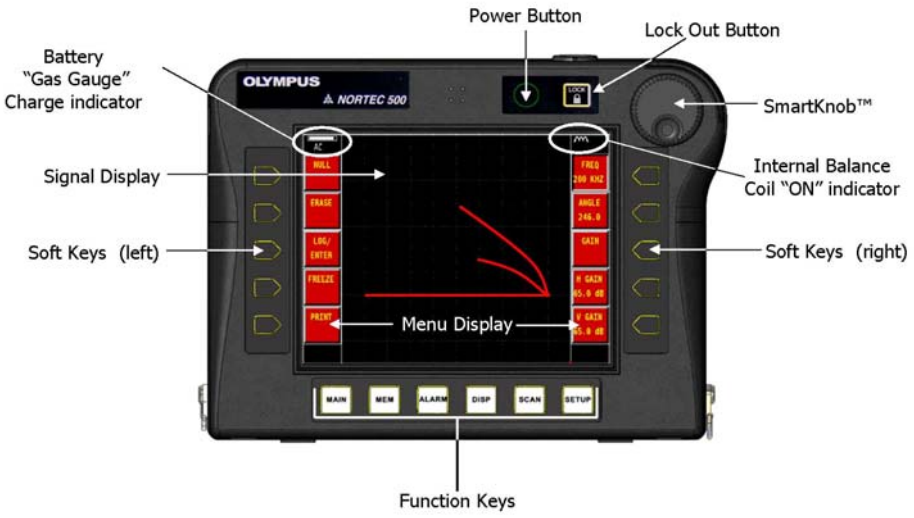


Figure 3.3: Instrument Controls

3.3 Power and Lock Button

The Power button toggles instrument power on and off. The instrument will normally attempt to restore its last configuration.

The Lock button disables most of the instrument FUNCTION KEYS, SOFT KEYS and SmartKnob™ when pressed. The only functions not disabled when this function is enabled are the NULL and ERASE function keys. When a "locked" function is attempted the error message "PARM LOCKED" will appear at the bottom of the instrument display indicating the LOCK feature is engaged.

To disable the "LOCK" feature simply press the LOCK button.

The instrument display contains a symbol ("Gas Gauge", see Figure 3.1 above) indicating remaining battery life and directly below it an "AC" icon which indicates the charger is connected.

When the unit has approximately ten minutes operating time remaining a status message in the battery level window indicates a low-battery condition. A low battery cut-off circuit will automatically switch off the unit to protect the batteries from excessive discharge.

3.4 Soft Keys (Left and Right Side)

The soft keys located on the left and right side of the display are used to select instrument parameters for adjustment (using the SmartKnob™). For some parameters the soft keys when pressed repeatedly will toggle through specific parameter settings (discrete steps). When a soft key is pressed, the parameter located in the display box directly beside the key, will be highlighted taking on the appearance of a depressed button

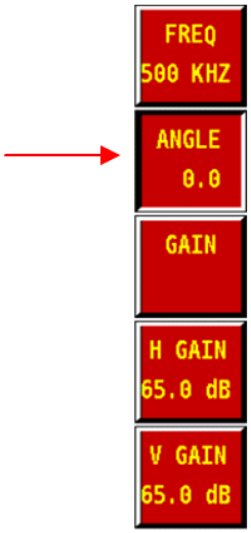


Figure 3.4: Example of Depressed Button

3.5 Display

The instrument is configured with a Color Liquid Crystal Display (LCD) and offers 640 x 480 resolution (Full VGA). The LCD Display shows the eddy current signal, menu display, status bar, annunciators, and when required full screen text.

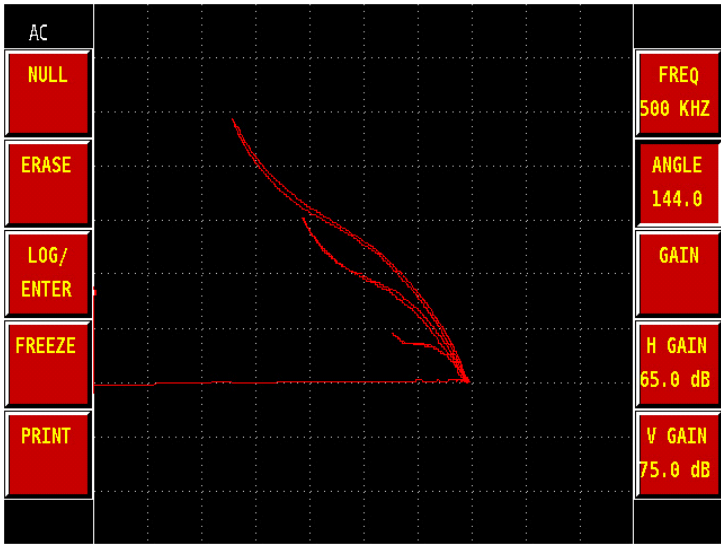


Figure 3.5: Display

3.6 SmartKnob™

The primary function of the SmartKnob™ is to change the selected instrument parameters. The parameter being adjusted will be highlighted taking on the appearance of a depressed button located to the right or left of the menu soft keys. In some instances the SmartKnob™ may be used to respond to various prompts.

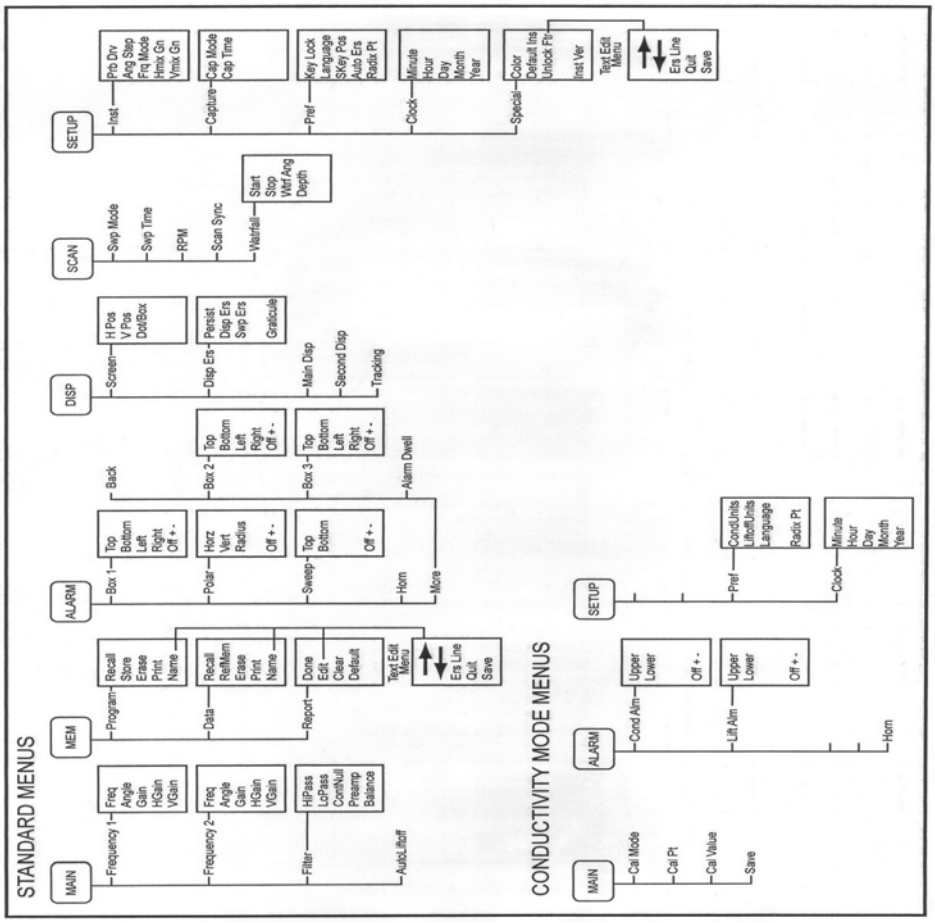
3.7 Function Keys

The Function keys (Figure 3.1) are used to activate an operating menu on the instrument. These keys are normally pressed first before changing values using the SmartKnob™ or menu soft keys.

The basic functions are found in the MAIN menu. These functions affect the basic eddy current operation of the instrument.

- MEM — The Memory menu contains the functions to store, recall, name, and delete data and programs.

- ALARM — The Alarm menu contains the functions for alarm operation.
- DISP — The Display menu controls settings that set the way in which the eddy current signal is displayed on the screen, as well as Persist, Display Erase and Sweep Erase.
- SCAN — The Scanner menu controls functions related to scanner functions such as Sweep Mode, Sweep Time, RPM, Sync Angle and Waterfall. Function key is present on the Nortec 500 but most functionality is limited to the Nortec 500S and Nortec 500D models.
- SETUP — The Setup menu contols functionality of the instrument such as Date and Time settings, probe drive, language settings, SOft Key left and right operation, and Capture setting



Menu Tree

3.8 Basic Functions

Terms (as shown on the instrument):

- GAIN (GAIN)
- FREQUENCY (FREQ1 or FREQ2)
- ANGLE (ANGLE)
- FILTER (FILTER)
- CONT NULL (CONTNUL)
- NULL (NULL)
- ERASE (ERASE)
- SWEEP (SWP MODE)
- DISPLAY (DISP)
- POSITION (V POS or H POS)
- PERSIST or Variable Persistence (PERSIST)
- SWEEP ERASE (SWP ERS)
- DISPLAY ERASE (DISP ERS)
- DOT/BOX (DOT/BOX)
- GRATICULE (GRATICUL)
- AUTO LIFTOFF (AUTOLIFT)

GAIN:

Gain is adjustable from 0.0 to 90.0 dB. The displayed gain setting is adjusted in 0.1 dB steps. At full gain (90.0dB) with the instrument probe drive set to “MID”, instrument sensitivity is 100 volts/ohm as measured on the side panel horizontal and vertical outputs, or 100 screen divisions per ohm on the display. (10 division display represents an impedance change of 0.1 ohm).

Gain may be adjusted in the horizontal or vertical directions or both together. Regardless of which gain parameters are being entered, the gain is adjusted by turning the SmartKnob™. With each press of the GAIN soft key, the gain increases by 5 dB. This can be both vertical and horizontal together, or independently.

.

Note: The first time that the “GAIN” keys are pressed the key is highlighted. The second time the keys are pressed the gain will be increased to a GAIN value ending in “0” or “5”. Once the GAIN value ends in “0” or “5” each time the GAIN keys are pressed the GAIN will increment by “5 dB”. To reduce the GAIN setting the SmartKnob™ must be used.

To adjust both horizontal and vertical gain, press the MAIN function key, then the FREQ1 SETUP soft key, then the GAIN soft key. The gain may then be adjusted with the SmartKnob™. The selected value will be applied to the horizontal and vertical gain and the difference between horizontal and vertical gains will remain the same, i.e. they will “track” together.

To adjust the horizontal gain without changing the vertical gain, press the H GAIN soft key. The SmartKnob™ will now adjust only the horizontal gain. Likewise, to adjust only the vertical gain, press the V GAIN soft key. The SmartKnob™ will now adjust only the vertical gain.

FREQUENCY:

The Frequency setting determines the frequency of the eddy current probe drive signal. This is adjustable from 50 Hz (0.05 kHz) to 12 MHZ.

To adjust the frequency, simply press the MAIN function key, then the FREQ1 SETUP (Frequency 1 Setup) soft key, then the FREQ soft key. Rotate the SmartKnob™ to adjust to the desired value.

ANGLE:

The Phase Angle (or rotation) of the eddy current signal is set with the ANGLE soft key. By default rotation is set in 1 degree increments from 0 through 359 degrees but may be changed to 0.5 or 0.1 “Angle Steps”.

To adjust phase angle, simply press the MAIN function key, then the FREQ1 SETUP soft key, then the ANGLE soft key. Rotate the SmartKnob™ to adjust to the desired value.

FILTER:

Low pass filters may be set from 10 Hz to 100 Hz in 1 Hz increments and 5 Hz increments up to 500 Hz followed by 25Hz increments up to 2000 Hz. High pass filters may be set from 0 Hz

to 500 Hz in 2 Hz increments up to 8 Hz. 1 Hz increments from 9 Hz to 100 Hz and 5 Hz increments up to 500 Hz.

To adjust the filter settings, simply Press the MAIN function key, then the FILTER SETUP soft key. Select either the LOWPASS soft key (Low Pass Filter) or the HIPASS soft key (High Pass Filter) to adjust the filter settings. Once the filter type has been selected, rotate the SmartKnob™ to the desired value.

CONTNUL:

CONTNUL (Continuous Null) allows a very low frequency high pass filter to be turned on and is useful to keep the null point of the eddy current probe at the point specified if required. This filter has a 0.2 Hz, 0.5 Hz, or 1 Hz, high pass filter when turned on. By default this feature is set to “OFF”.

To turn on continuous null, simply press the MAIN function key, followed by the FILTER SETUP soft key, then the CONTNUL soft key. Rotate the SmartKnob™ to adjust to the desired value.

BALANCE:

Allows selection of internal balance coils for the use of single coil bridge probes. Choices include 1.2 µh, 8.2 µh, 15 µh, 22 µh, 47 µh, 82 µh, and 120 µh. Due to the variety of probe manufacturers determining which internal balance coil to use with a given probe, trial and error may be needed. The internal balance coil that is best suited will have the better signal to noise ratio and produce the best flaw amplitude when using the same frequency and gain settings for all internal balance coils being evaluated.

Note: When the internal balance coil feature is activated, the following icon displays in upper right corner:

The internal balance coils should be used only with probes connected to the BNC connector on the top rear of the instrument!

Figure 3.5.1 Internal Balance Coil Icon

NULL:

The Null function moves the dot (impedance plane display or sweep display) to the selected null position, often in the middle of the screen. This function is implemented simply by pressing the NULL button. Null should be performed prior to performing a test, and at periodic intervals when performing eddy current tests. Refer to the test procedures for a specific test to determine whether to null the signal with the probe held in air or on the test part.

ERASE:

The Erase function will perform a screen erase when the ERASE key is pressed during normal operation. This operation clears all data from the screen and is useful to eliminate screen clutter. To erase the screen at any time the eddy current signal is displayed, press the ERASE soft key.

Note: The instrument is also capable of automatically erasing the screen by using the DISP ERS (Display Erase) or PERSIST (Variable Persistence) functions.

SWEEP: (Limited functionality in the Nortec 500)

The Sweep feature on the Nortec® 500 instrument is controlled under the SCAN menu. Sweep moves the signal horizontally at a fixed rate selected from the front panel, continually retracing across the screen. The sweep functions are detailed below.

- Auto Sweep may be set in the range from 0.005 seconds (5 milliseconds) per division to 4 seconds per division. At sweep time periods of 0.055 seconds/division and longer the display will update in an incremental fashion. Auto Sweep displays both the horizontal amplitude and vertical amplitude of the eddy current signal in a combined single horizontal sweep across the instrument screen.
- Auto XY Sweep may be set in the range from 0.005 seconds (5 milliseconds) per division to 4 seconds per division. At sweep time periods of 0.055 seconds/division and longer the display will update in an incremental fashion. Auto XY Sweep displays the horizontal amplitude and vertical amplitude of the eddy current signal in two individual horizontal sweeps (X & Y) across the instrument screen. The upper sweep representing the horizontal amplitude of the eddy current signal and the lower sweep representing the vertical amplitude of the eddy current signal
- External Sweep synchronizes the sweep to the rotation of the attached optional scanner. (Nortec 500 S and Nortec 500D only)
- External/ Impedance Sweep (also known as “Split Screen”) in this mode, External Sweep is on the left screen and Impedance Plane is on the right. Any adjustment to the Impedance Plane signal is linked to the External Sweep display. (Nortec 500 S and Nortec 500D only)
- Waterfall Sweep: displays the sweeps associated the “Waterfall” function when used with the optional PS5AL scanner. See section 3.14 for more information on the feature. (Nortec 500 S and Nortec 500D only)

To turn on a specific Sweep function, press the SCAN function key, followed by the SWP MODE (Sweep Mode) soft key. Rotate the SmartKnob™ to adjust to the sweep function.

DISPLAY:

The Display feature contains menu parameters that control Signal Position, Persist, Display Erase, Sweep Erase and Graticule. The following parameters may be changed:

POSITION:

The Position feature controls the position of the eddy current signal display. When the NULL key is pressed or the signal is in a null state, the dot or sweep line will be in the null position selected. Position may be controlled in steps of 0.5% of full screen, with the lowest values at the bottom left of the screen

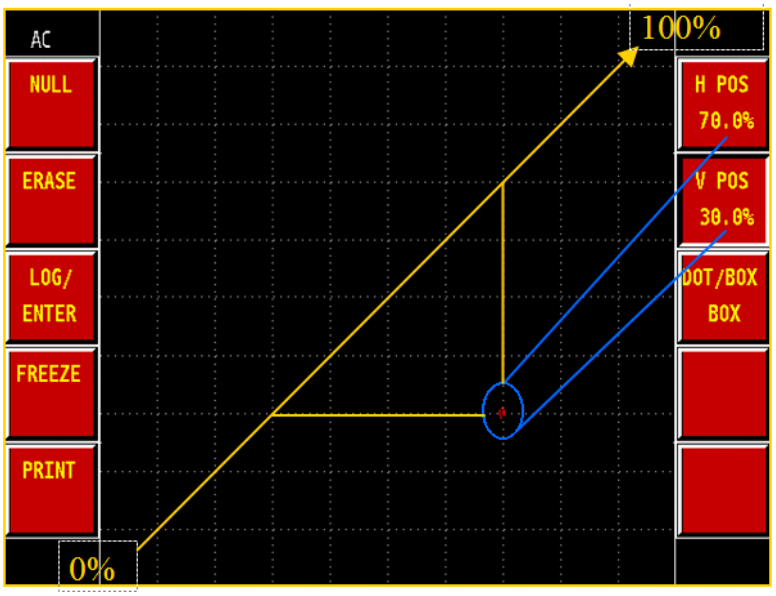


Figure 3.5.2 Null Position

To change position (also known as null position) first press the DISP function key, then the SCREEN SETUP soft key, then choose either H POS soft key (Horizontal Position) or the V POS soft key (Vertical Position) soft key. Rotate the SmartKnob™ to adjust to the desired value.

PERSIST:

Persist (Variable Persistence) is a mode of automatic screen erase. It allows the operator to set an impedance plane (not sweep) display so that the signal traces on the screen will be erased after a selected amount of time. This time may be set from 0.1 to 5 seconds, in 0.1 second increments.The variable persistence will erase the information at a particular point after the time has expired, even if more information was displayed there at a later time. The result of this is that the display may appear somewhat broken where eddy current signals intersect those being erased.

Despite this, the resultant display is very useful for repetitive testing, averting the need for manually erasing the screen. This function is not allowed when DISP ERS (Display Erase) or SWP MODE (Sweep Mode) is active.

To activate the PERSIST function (Variable Persist) first press the DISP function key, then the D ERASE SETUP soft key, then press the PERSIST soft key. Rotate the SmartKnob™ to adjust to the desired value.

SWP ERS: (Nortec 500 S and Nortec 500D only)

SWP ERS (Sweep Erase) function erases the sweep display once per trace. In the Sweep Mode, traces that are set for 0.055 seconds (55 milliseconds) per division or longer, will erase incrementally as each new set of data is drawn to the screen. Thus, all data will be on the screen for the same amount of time, regardless of its horizontal position on the sweep display.

The sweep erase function only applies to the sweep mode. Refer the above explanation of SWEEP for further information on this function. When the erase function is turned off, the sweep display will have to be erased manually.

When the instrument is loaded with its default settings, the Sweep Erase function is set to ON, which is the normal mode of operation.

To activate SWP ERS (Sweep Erase), press the DISP function key, followed by the D ERASE SETUP soft key then press the SWP ERS soft key. Rotate the SmartKnob™ to adjust to the desired value.

DISP ERS:

DISP ERS (Display Erase) erases the eddy current display at intervals set by the operator. The available range for the display erase function is from 0.1 to 60 seconds in 0.1 second intervals. This function differs from variable persistence in that the screen is completely erased at each interval, rather than incrementally erased.

The Display Erase function is not allowed when PERSIST (Variable Persistence) is turned on.

To activate DISP ERS (Display Erase) press the DISP function key, followed by the D ERASE SETUP soft key then press the DISP ERS soft key. Rotate the SmartKnob™ to adjust to the desired value.

DOT/BOX:

The Dot/Box feature allows the operator to change the shape of the signal focal spot. The default is the larger square box. A smaller dot is also obtainable.

To adjust the DOT/BOX function first press the DISP function key followed by the SCREEN

SETUP soft key, then press the DOT/BOX soft key. Rotate the SmartKnob™ to adjust to the desired value.

GRATICULE:

The 10x10 Graticule may be set on or off at any time without affecting any eddy current information on the display.

To turn on or off the Graticule function first press the DISP function key followed by the D ERASE SETUP (Display Erase Setup) soft key, then press the GRATICUL (Graticule) soft key. Rotate the SmartKnob™ to adjust to the desired value.

AUTOLIFT:

AUTOLIFT (Auto Liftoff) automatically adjusts the phase angle produced from the liftoff. To access the AUTOLIFT feature, press the MAIN function key followed by the AUTOLIFT soft key. Pressing the AUTOLIFT soft key a second time starts the Auto Liftoff compensation process.

To use AUTOLIFT:

1. Using an eddy current probe, maintain contact with the material and press the AUTOLIFT soft key twice. The probe will Null.
2. When “LIFT PROBE” appears in the display, slowly tilt the probe off the material.When the instrument trace moves across the instrument screen the process is finished. The liftoff trace now points toward the left of the screen horizontally.

3.9 Alarm Operation

The Nortec® 500 will operate using either a box or polar (circular) alarm in the impedance plane mode. In the sweep modes, the alarm is a threshold alarm that senses a crossing in the vertical direction.

All alarms respond to the eddy current signal as it is being processed, and therefore react rapidly. The operation of the alarms may be dwelled, which is a function that forces the alarm to be on for a minimum amount of time. An internal audible alarm horn may be turned on, and will respond to the alarm condition subject to the dwell function settings. Finally, on screen alarm indicators flash on screen when the instrument is in an alarm condition.

Box or polar alarms may be used at the same time in impedance plane mode. One polar alarm and three box alarms are available. When the instrument is placed into the sweep mode, only a threshold (sweep) alarm is available.

All alarms may be set individually to positive or negative polarity. Positive polarity forces the alarm to be on whenever the eddy current signal is inside the alarm threshold, while negative polarity activates the alarm whenever the eddy current signal is outside the alarm threshold.

The ALARM function key enables the user to activate the ALARM SETUP soft keys to turn the alarm on/off, set its size, position and polarity.

ALARM SETUP is divided in two (2) menus with “BOX 1 SETUP”, “POLAR SETUP” “SWEEP SETUP”, “HORN” and “MORE” being the options allowed for setup from the first menu. Upon pressing “MORE” the options available are “BACK”, “BOX 2 SETUP”, “BOX 3 SETUP” and “ALM DWELL” (Alarm Dwell). After pressing an ALARM SETUP soft key the operator now has the ability to control the ALARM functions. The extent and position of the alarms can be defined, polarity set, audible horn turned on/off and alarm dwell time adjusted. The SmartKnob™ is used to change the values for the alarm functions.

Prior to adjusting the alarm, the proper Alarm Type needs to be selected by pressing one of the available ALARM SETUP soft keys. The available alarm types are the box, polar (circular) and sweep.

To select the alarm type, press the ALARM function key. The five soft keys will change to indicate the options available, “BOX 1 SETUP”, “POLAR SETUP” “SWEEP SETUP”, “HORN” and “MORE” (MORE options). Pressing the “MORE” soft key will allow more options to be adjusted including “BACK” (BACK to previous menu), “BOX 2 SETUP”, “BOX 3 SETUP” and “ALM DWELL” (Alarm Dwell). Press the soft key you wish to adjust. The SmartKnob™ is used to change the values for the alarm functions.

Each alarm is turned on/off separately. Therefore, if the alarm type is changed it will have to be activated if it was previously turned off. Once the alarm type is selected, it may be turned on/off and set to positive or negative polarity through one of the ALARM SETUP soft keys. For further details refer to the individual alarm functions on the next pages.

Note: When SPLIT SCREEN is set to ON, Box and Polar alarms are identical on both screens.

3.9.1 Box Alarm

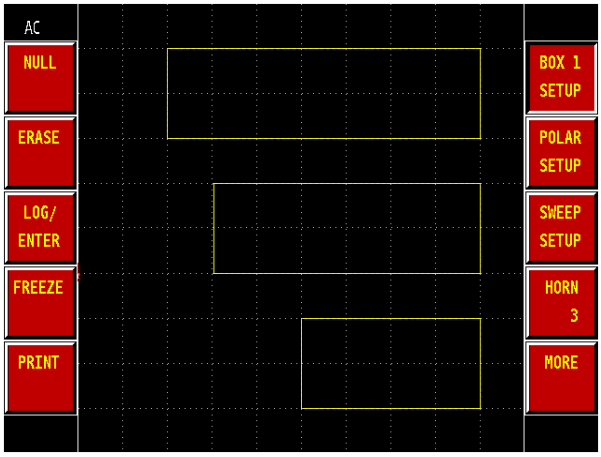


Figure 3.6: Box Alarm Display

The Box Alarm is a rectangular box that represents limits to the allowable signal excursion before an alarm threshold setting is crossed. The box alarm is the most commonly used alarm and is specified in many test procedures (see Figure 3.6.1, above).

The box alarm on the Nortec® 500 has the additional feature in that, if it should touch the edge of the screen, the alarm box will be considered to extend beyond the edge of the screen, allowing the setup of a quadrant alarm.

To select the alarm that will be adjusted press the soft key corresponding to the BOX alarm desired (1, 2, or 3). Once the proper alarm has been selected, it may be turned on to positive or negative polarity by pressing the -/+ /OFF soft key and rotating the SmartKnob™.

To adjust the limits of the alarm go to the simply press the TOP, BOTTOM, LEFT or RIGHT soft key.

Once the side to be adjusted has been selected, the SmartKnob™ will allow movement of that side. The menu display will indicate as a percentage of the screen the location of the side of the alarm.

3.9.2 Polar Alarm

The Polar Alarm is a circular alarm that is normally used to detect only a magnitude change beyond a certain threshold for the eddy current signal. The operator may vary the size and

position of the polar alarm, although its default position at the center of the screen is normally the best position.

To activate polar alarm press the ALARM function key followed by the POLAR SETUP soft key then the -/+ /OFF soft key to select positive or negative polarity as desired. Once the alarm appears on the screen, its size may be adjusted by selecting the RADIUS soft key.

The POLAR alarm may be moved by selecting the desired direction by pressing either the HORZ (Horizontal) or the VERT (Vertical) soft key and rotating the SmartKnob™ to move it. The menu display will indicate the screen position.

3.9.3 Sweep Alarm

The Sweep Alarm is a simple high/low threshold alarm and is available when the Nortec® 500 instrument is operated in Sweep Mode. This alarm is the only available alarm when the SWP MODE (Sweep Mode) is active.

The polarity of the Sweep Alarm may be positive or negative. The negative alarm is normally used, triggering the alarm whenever one of the thresholds is exceeded. The positive alarm may be used when it is desired to have an alarm in only one direction.

To activate the SWEEP ALARM press the ALARM function key, then the SWEEP SETUP soft key and press the -/ + /OFF menu soft key, rotate the SmartKnob™ until the menu readout displays POSITIVE or NEGATIVE as appropriate.

The TOP and BOTTOM soft keys allow the operator to adjust the top and bottom threshold. Pressing the TOP or BOTTOM soft key, followed by rotating the SmartKnob™ will change the selected threshold.

- ALARM HORN: The Alarm Horn is an audible annunciator. This horn is internal to the instrument and is best used when background noise in the testing area is low. The Alarm Horn is turned on/off by pressing the ALARM function key, followed by the HORN soft key. Rotating the SmartKnob™ clockwise turns the horn on and increases the horns volume. Rotating the SmartKnob™ counter-clockwise decreases the horns volume and turns the horn off. There are four volume levels available for the alarm horn, OFF, 1 (low), 2 (mid) and 3 (High).
- ALARM DWELL: Alarm Dwell keeps the alarm ON for a set period after the event that caused the alarm has ended. Thus, if alarm dwell is set for 1 second and an alarm occurs, the instrument will continue to alarm for a period of 1 second after the alarm condition is over. Alarm Dwell may be set in increments of 0.2 second from 0.0 (off) to 10.0 seconds. Dwell applies to the alarm on screen indicators and the alarm horn (if on). To change Alarm Dwell, press the ALARM function key, then press the MORE soft key followed by

the ALM DWEL (Alarm Dwell) soft key. The value may be entered by rotating the SmartKnob™.

3.10 Dual Frequency Mode (Nortec 500D Only)

The operation of a Dual Frequency Nortec® 500 is an extension of single frequency operation. Parameters that are adjustable for the second frequency are Frequency, Gain, and Rotation. Dual Frequency mode is controlled via the SETUP menu.

To enable dual frequency mode first press the SETUP function key followed by the INST. SETUP (Instrument Setup) soft key and then the FRQ MODE (Frequency Mode) soft key. The value may be changed between SINGLE and DUAL FRQ (Dual Frequency) by rotating the SmartKnob™. By default FRQ MODE (Frequency Mode) is set to SINGLE frequency.

Note: The Nortec® 500 instruments always attempt to power up in the same manner as it was turned off. Therefore if the frequency mode = “DUAL FRQ” (Dual Frequency On) on shutdown then the instrument will power up with frequency mode = “DUAL FRQ” (Dual Frequency On). Dual frequency must be turned on or off each time it is required or not required. By performing DEFAULT INST. (Instrument Default) function, FRQ MODE (Frequency Mode) is set to SINGLE frequency (FRQ MODE SINGLE). See section 3.12 for more information on DEFAULT INST. (Instrument Default) function.

Second frequency controls are as follows:

- The FREQ2 (Frequency 2) soft key controls the frequency of the Nortec® 500. The allowable range for this setting is ½ to 1/32 of the main frequency. To change the FREQ2 (Frequency 2) setting, press the MAIN function key followed by the FREQ2 SETUP soft key. Adjust Frequency 2 by pressing the FREQ2 (Frequency 2) soft key and rotate the SmartKnob to the desired frequency.
- ANGLE2: The ANGLE2 (Angle 2) soft key controls the phase angle of Frequency 2. However, if TRACKING is ON (see below), the Angle 2 option controls the phase angle of both Frequency 1 and Frequency 2. The phase angle for Frequency 2 is always displayed. To change the angle setting for Frequency 2, press the MAIN function key followed by the FREQ2 SETUP soft key and then the ANGLE2 soft key. The ANGLE2 may now be adjusted by rotating the SmartKnob™.

- GAIN2: The GAIN2 (Gain 2) soft key controls the gain applied to the frequency 2 signal, or if TRACKING is ON, the gain of both frequency 1 and frequency 2. The gain setting on Frequency 2 is always displayed. To change the gain setting for Frequency 2, press the MAIN function key followed by the FREQ2 SETUP soft key and then the GAIN2 soft key. Adjust the gain of Frequency 2 by rotating the SmartKnob™.
- HGAIN2: The HGAIN2 (Horizontal Gain 2) soft key controls the horizontal gain of Frequency 2, or if TRACKING is ON, the horizontal gain of both Frequency 1 and Frequency 2. The horizontal gain of frequency 2 will always be displayed. To change the horizontal gain setting for Frequency 2, press the MAIN function key followed by the FREQ2 SETUP key and then the HGAIN2 soft key. Adjust the horizontal gain of Frequency 2 by rotating the SmartKnob™.
- VGAIN2: The VGAIN2 (Vertical Gain 2) soft key controls the vertical gain of Frequency 2, or if TRACKING is ON, the vertical gain of both Frequency 1 and Frequency 2. The vertical gain of frequency 2 will always be displayed. To change the vertical gain setting for Frequency 2, press the MAIN function key followed by the FREQ2 soft key and then the VGAIN2 soft key. Adjust the vertical gain of Frequency 2 by rotating the SmartKnob™.
- DUAL DISPLAY: Dual display is used is used to see both Frequency 1 and Frequency 2 display signals at the same time. To enable the DUAL DISPLAY first the instrument must be set to operate in Dual Frequency mode. First press the SETUP function key followed by the INST. SETUP (Instrument Setup) soft key. Now press the FRQ MODE (Frequency Mode) soft key. The FRQ MODE (Frequency Mode) of the Nortec® 500 can be changed from SINGLE mode (FRQ MODE SINGLE) to DUAL FREQUENCY (FRQ MODE DUAL FRQ) by rotating the SmartKnob™.
- MAIN DSP: The MAIN DSP (Main Display) controls the data on the main display. The main display is the only display when 2ND DSP (Second Display, detailed later in this section) is OFF, or the left side of the display when 2ND DSP (Second Display) is ON. To change the MAIN DSP (Main Display) setting, press the DISP function key followed by the MAIN DSP soft key. Adjust the setting by rotating the SmartKnob™. The selections available are as follows:
  - F1 display frequency 1 data
  - F2 display frequency 2 data
  - F1+F2 display sum of frequency 1 and frequency 2 data
  - F1-F2 display difference of frequency 1 and frequency 2 data
- 2ND DISP: The 2ND DISP (Second Display, also known as “Split Screen”) controls whether only the main display is shown, or the main and second display screens are shown in a split screen format. When using a scanner in the split screen mode the swept display will be on the left with the impedance display on the right. To change the 2ND DISP (Second Display) setting press the DISP function key followed by the 2ND DISP (Second

Display) soft key. Adjust the setting by rotating the SmartKnob™. When 2ND DSP (Second Display) is ON, the following adjustments are possible:

— F2 display frequency 2 data and frequency 1 data.

— F1+F2 display sum of frequency 1 and frequency 2 data.

— F1-F2 display difference of frequency 1 and frequency 2 data.

Note: When 2ND DISP (Second Display) is set to ON, the timed DISP ERASE (Display Erase) function and alarms are available, but variable persistence function is not.

- TRACKING: The Tracking feature controls either the Angle/Gain parameters for both Frequency 1 & 2, or only the Frequency 2 gain and rotation. If this feature is ON, any adjustment to angle affects both frequency 1 and 2 angles, adjusting horizontal gain on the MAIN 2 menu affects both frequency 1 and 2 horizontal gain, and so forth. To change the TRACKING feature, press the DISP function key followed by the TRACKING soft key. Adjust the setting by rotating the SmartKnob™.

3.11 Program Storage

The Nortec® 500 is capable of storing and retrieving complete instrument setups. The setups are recorded with date and time, and may be named using up to 29 alphanumeric characters. These names are input directly from the front panel of the instrument or by using EddyMaster 500 software (included with each instrument).

Whenever a program setting is recalled, the currently active instrument settings are overwritten and cannot be recovered unless these settings were previously stored in another program location.

Functions pertaining to PROGRAM storage are as follows:

- STORE saves the current instrument settings to the selected program location.
- RECALL programs the instrument settings with the selected program number.
- ERASE erases the selected program number.
- NAME allows the operator to set a name to the program for easier reference.
- PRINT allows printout of all the program settings to a USB printer.

Program storage locations are automatically assigned and are accessed by pressing the MEM function key.

To use any of the program features, first press the MEM function key followed by the PROGRAM SETUP soft key. Program storage locations will until “named” record the time and date the program was saved. It is recommended that the stored program locations be named for easy recall at a later time immediately after storing the program. Functions that apply to program storage locations are RECALL, ERASE, NAME, and PRINT.

Once a program has been saved, the RECALL, ERASE, NAME, and PRINT function can be initiated by first selecting the desired program with the SmartKnob? and then pressing the appropriate menu soft key.

After performing the desired operation, any of the function keys, such as, MAIN or DISP will return the instrument to normal operation.

3.11.1 STORE

STORE records the instrument settings currently in use to a storage location. All instrument settings, including alarm, are saved to the program. Once a program is stored, it may be named using the NAME ITEM program function.

To store a setup, make sure that the settings the instrument is currently using are the desired ones. Press the MEM (Memory) function key followed by the PROGRAM SETUP soft key. Press the STORE menu soft key twice to store the program. The display screen will be redrawn and the selected location will be listed with the time of day and the date the program was stored. If it is desired to name the program setting, perform the NAME function outlined in this section.

3.11.2 NAME

The NAME function allows the operator to enter a name of up to 29 characters for a stored program. Names may be used to describe the test settings that are stored, reference a written test procedure, and so on. Only programs that are not empty may be named. All capital letters will be used, together with the digits 0 through 9 and several special characters (. / # %) and blanks. When the name feature is selected, a screen similar to the figure below will appear, displaying a list of available characters, and a highlighted entry line with an (^) arrow used to point to the current character being entered.

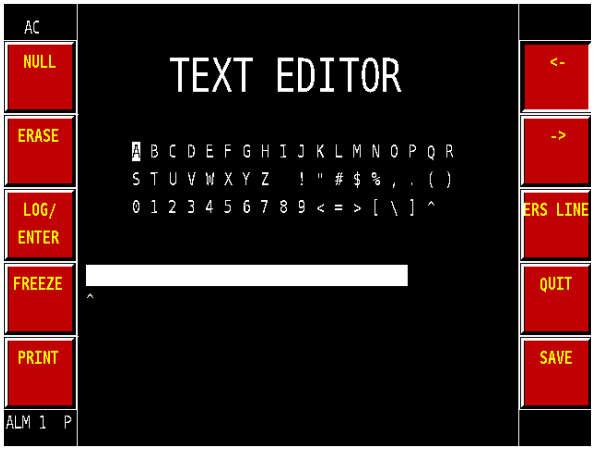


Figure 3.7 Text Editor

Pressing the LOG/ENTER soft key selects the character and moves the (^) arrow on the entry line to the right one character.

Pressing the SAVE menu soft key twice will record the name changes made into the current program setting.

Pressing the QUIT soft key or any function key will eliminate any changes made, retain its original value, and exit the NAME function.

3.11.3 RECALL

The RECALL function changes the current instrument settings to those stored in the selected program storage location. Any settings used by the instrument prior to performing this function are overwritten.

To recall a setting from the instrument, press the MEM (Memory) function key followed by the PROGRAM SETUP soft key. Rotate the SmartKnob™ until the display highlights the desired program number. Once the location has been selected, press the RECALL soft key twice to load the program settings into the instrument.

3.11.4 ERASE

The ERASE function allows the operator to erase the selected program setting. This is normally done before saving a new program.

In order to erase a program setting, press the MEM (Memory) function key followed by the PROGRAM SETUP soft key. Rotate the SmartKnob™ until the program storage location you wish to erase is highlighted. Once it is highlighted press the ERASE soft key twice. Once this is done, a message to verify the erase function appears at the bottom of the instrument screen. When the message “PRESS LOG TO VERIFY?” appears, press the LOG/ENTER soft key to erase or any other soft key or function key to escape.

3.11.5 PRINT

The program PRINT function uses the optional external USB printer to make a hard copy of the currently selected program settings, listing all settings including alarm levels and status.

To use this feature, a USB printer must be properly attached and operating. If a printer is not properly connected, selecting the PRINT function will cause the error message PRINT ERROR to display at the bottom of the instrument screen.

Printing a program setting requires first that the desired program number be selected. Then, simply pressing the PRINT menu soft key will start the printout.

3.12 Data Storage

The Nortec® 500 has an extensive selection of data storage capabilities. Data may be stored using one of three different methods, and once stored, the information and instrument setups may be accessed in a variety of ways.

Data may be stored as frozen data, captured data or waterfall data. Frozen data (FREEZE) captures an image as it is displayed on the screen, “frozen” at that instant of time. Captured data saves data for a period of time from 2.5 to 60 seconds, and can replay this data back to the screen, complete with alarms. Waterfall data is data captured from a waterfall (multiple sweeps) display using a PS-5AL scanner. It is the only data that can be modified after it is captured (see Section 3.16 on Waterfall Display).

The captured data may be recorded using one of three modes:

1. FREEZE captures an immediate image as it is displayed on the screen, “frozen” at that instant of time.

2. CAP ONCE (Capture Once) starts recording the capture as soon as the operation is selected, and will automatically end when the selected time has been reached.
3. CAPT CONT (Capture continuous) stops recording data when the operation is ended and automatically stores the preceding data for the allotted time period. This capture is ended manually by pressing the LOG/ ENTER soft key.

When the capture continuous is ended, the information stored is the information that was being recorded at the end of the capture.

Once data has been stored through the frozen (FREEZE), capture (CAPT ONCE or CAPT CONT) or waterfall methods, the following list provides the various options for the stored data.

- Data may be recalled to the screen for viewing.
- The data may be printed out on an inspection report.
- The instrument settings in effect when the data was stored may be reviewed or restored to the instrument as outlined in Section 3.10, Program Storage.
- The data and/or instrument settings may be downloaded to an external computer for further processing.

Twenty data storage locations are available. When any of the storage functions are selected, the status line shows both the storage location number and the status of the storage:

The functions available through the DATA storage are: RECALL, REF MEM (Reference Memory) ERASE, PRINT and NAME ITEM.

RECALL: To recall a stored data, first press the MEM (Memory) function key. Then select the desired storage location using the SmartKnob™. Press the RECALL menu soft key twice to recall the stored image. Frozen data will be displayed immediately; while captured (replay) data will be displayed at the same rate it was recorded. Once the display is finished, press any function key to revert the display back to the listing of stored data.

ERASE: The data storage Erase function provides the operator with the means to clear a single storage location. In order to perform the ERASE data function, press the MEM (Memory) function key followed by the DATA SETUP soft key. Then select the storage location by rotating the SmartKnob™ until the desired location is selected. Once the location number is selected, press the ERASE key a second time. The status line will display “PRESS LOG TO VERIFY?”. Press the LOG/ENTER soft key to erase the location or any other key to abort.

NAME ITEM: The data storage NAME ITEM function allows the operator to enter a name of up to 29 characters for DATA and PROGRAM file locations. Names may be used to describe the test results that are stored, reference a written test procedure, and so on. Only file locations that have data in them may be named. When naming storage locations, all capital letters may

be used, together with the digits 0 through 9, several special characters (. / # %) and blanks. When the name function is selected, the text editor screen will appear (see Figure 3.10.2) displaying a list of available characters, and a highlighted entry line with an (^) arrow used to point to the current character space selected.

Rotating the SmartKnob™ moves the highlight from character to character.

Pressing LOG/ENTER soft key selects the character and moves the arrow on the entry line to the right one character.

The SAVE soft key will record the changes made to the current stored data number.

The QUIT soft key will return the name to its original value prior to selecting this function.

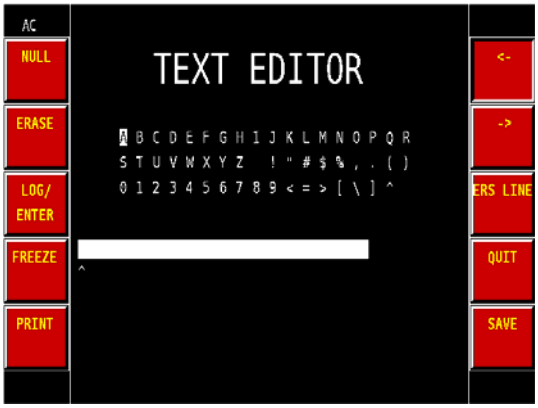


Figure 3.8 Text Editor

PRINT: The data storage PRINT function uses the optional external USB printer to make a hard copy of the information in the currently selected data storage location. This printout includes the screen data and all instrument settings that were in effect at the time the data was saved. In addition, this information is presented in an inspection report format that can be customized to suit individual needs.

To use this feature, a USB printer must be properly attached and operating. If a printer is not properly connected, selecting the print function will cause the error message * PRINT ERROR * to display on the instrument screen.Printing stored data requires first pressing the MEM (Memory) function key. Then, the desired location number is selected by rotating the SmartKnob™. After this is done, simply press the PRINT soft key and the printout will begin.

3.13 Setup Menu

The Setup menu allows the user to set and load defaults for the Nortec® 500 These include probe drive, frequency mode (dual or single), capture mode and capture time, user preferences for language and soft key orientation, clock settings and screen color choices. This menu also allows access to the “default instrument” option should the need arise to reset the instrument.

Figure 3.9 N500 Setup Screen

PROBE DRIVE: The Nortec® 500 instrument has 3 levels of probe drive that are operator selectable. These levels are denoted as LOW, MID, and HI. The approximate peak to peak voltages for each are 2, 6, and 12 volts, respectively.

Mid probe drive (default) is normally sufficient for most eddy current testing. However, there are certain instances where high probe drive is desirable:

- Insufficient gain at lower probe drive setting
- Testing lower conductivity materials

- Finding smaller flaws in the test material
- Deeper penetration into test material

To set the probe drive level, press the SETUP function key, followed by the INST. SETUP (Instrument Setup) soft key followed by the PROB DRV (Probe Drive) soft key. Once the probe drive function is selected, it may be changed by rotating the SmartKnob™ until the desired level is selected.

ANG STEP: ANG STEP (Angle Step) is used to change the rotation angle (MAIN Menu) steps in increments of 1.0 (coarse), 0.5 (medium) or 0.1 (fine). The default is 1.0 (coarse) but can be decreased to improve the accuracy of the angle function.

To set the ANG STEP (Angle Step) response level, press the SETUP function key, followed by the INST. SETUP (Instrument Setup) soft key followed by the ANG STEP (Angle Step) soft key. Once the ANG STEP function is selected, it may be changed by rotating the SmartKnob™ until the desired level is selected.

FRQ MODE: (Nortec 500D Only) FRQ MODE (Frequency Mode) is used to change the Nortec® 500 instrument from a single frequency instrument to a dual frequency instrument.

To change the FRQ MODE (Frequency Mode):

1. Press the SETUP function key, followed by the INST. SETUP (Instrument Setup) soft key followed by the FRQ MODE (Frequency Mode) soft key.
2. Once the FRQ MODE function is selected, it may be changed by rotating the SmartKnob™ until the desired frequency mode is selected, “SINGLE” or “DUAL”.

HMIX GN: (Nortec 500D Only) HMIX GN (Horizontal Mix Gain) allows additional gain to be applied to the mixed signal (F1 + F2 and F1 – F2) signal path. This can be done be adjusted from 0 to 12db. It does not change any of the settings that apply to frequency 1 or frequency 2 individually.

VMIX GN: (Nortec 500D Only) VMIX GN (Vertical Mix Gain) allows additional gain to be applied to the mixed signal (F1 + F2 and F1 – F2) signal path. This can be done be adjusted from 0 to 12db. It does not change any of the settings that apply to frequency 1 or frequency 2 individually.

To change HMIX GN or VMIX GN, press the SETUP function key, followed by the HMIX GN (Horizontal Mix Gain) or VMIX GN (Vertical Mix Gain) soft key. Once the HMIX GN or VMIX GN function is selected, it may be changed by rotating the SmartKnob™. HMIX GN or VMIX GN may be set from 0 db (off), +6 db or +12 db.

Note: Changes to HMIX GN (Horizontal Mix Gain) or VMIX GN (Vertical Mix Gain) must be applied in the MAIN DSP = F1 window when displaying only frequency one on the instrument display or in dual display mode with the left screen (MAIN DSP) = F1.

CAP MODE: CAP MODE (Capture Mode). The Nortec® 500 has an extensive selection of data storage capabilities. Data may be stored using one of three different methods, and once stored, the information and instrument setups may be accessed in a variety of ways. See section 3.11 for details.

To access CAP MODE (Capture Mode), press the SETUP function key followed by the INST. SETUP (Instrument Setup) soft key and then the CAPTURE SETUP soft key. Once CAP MODE (Capture Mode) is selected, the mode of capture may be changed by rotating the SmartKnob™.

CAP TIME: CAP TIME (Capture Time) sets the time period for the length of the CAP ONCE (Capture Once) and CAP CONT (Capture Continuous) commands. The time period available is from 2.5 to 60 seconds in steps of 2.5 seconds. Choosing this time period is based on the time required and the speed of the test data being recorded. Shorter periods of time offer higher resolution, and will capture brief movements of the eddy current signal. Longer periods of time record slow moving data well, but faster data may appear coarse when replayed. Selection of the time period may require some trial and error testing for optimum results. See section 3.11 for complete details on this function.

LANG: LANG (Language), this function sets the language used for menu text. Selections include English, Spanish, French, German, and Italian.

To change LANG (Language), press the SETUP function key, followed by the INST. PREFS (Instrument Preferences) soft key followed by the LANG (Language) soft key. Once the LANG function is selected, it may be changed by rotating the SmartKnob™ until the desired LANG setting is selected. The screen text changes immediately to the chosen language.

SOFTKEY: SOFTKEY (left and right side soft keys, see Figure 3.1), this function in conjunction with left and right side interchangeable hand strap, allows the operator to change the soft keys from right handed to left handed operation.

To change SOFTKEY (Soft Key), press the SETUP function key, followed by the INST. PREFS (Instrument Preferences) soft key followed by the SOFTKEY soft key. Once the SOFTKEY function is selected, it may be changed by rotating the SmartKnob™ until the

desired SOFTKEY setting is selected. The Soft Keys change immediately (left or right) when the SmartKnob™ is rotated.

AUTO ERS(All models)

AUTO ERS (Auto Erase), this function controls whether the instrument screen is automatically erased after the NULL soft key is pressed. The default setting is “ON” or set to automatically erase the screen after the null function is performed.

To change AUTO ERS (Auto Erase), press the SETUP function key, followed by the INST. PREFS (Instrument Preferences) soft key followed by the AUTO ERS soft key. Once the AUTO ERS function is selected, it may be changed by rotating the SmartKnob™ until the desired AUTO ERS setting is selected.

RADIX PT: RADIX PT (Radix Point or decimal separator) radix point refers to the symbol used in numerical representations to separate the integral part of the number. The radix point can be changed between a small dot (decimal point) or a comma (,) by rotating the SmartKnob™.

To change RADIX PT (Radix Point or decimal separator), press the SETUP function key, followed by the INST. PREFS (Instrument Preferences) soft key followed by the RADIX PT soft key. Once the RADIX PT function is selected, it may be changed by rotating the SmartKnob™ until the desired RADIX PT setting is selected. The RADIX PT changes immediately when the SmartKnob™ is rotated.

CLOCK: CLOCK, date and time are kept internally in the Nortec® 500 instruments. This information is shown on program and data printouts, and the date is also shown on the listings of stored programs and eddy current data. Occasionally, it may be necessary to change the date or time, such as, when the instrument is transported across time zones.

To change CLOCK (Date and Time settings), press the SETUP function key, followed by the CLOCK SETUP soft key followed by the desired soft key next to “MINUTE”, “HOUR”, “DAY”, “MONTH” and “YEAR”. Once the desired item is selected, it may be changed by rotating the SmartKnob™ until the desired setting is correct. Once the all the desired changes have been made pressing the MAIN key will make the changes current and exit the CLOCK menu.

Note: The N500 uses 24 hour time convention for its internal clock.

COLORS: COLORS (Color Palette), changes the color scheme on Nortec® 500 models. To

change COLORS (Color Palette), press SETUP and SPECIAL SETTINGS.

Colors may be changed when COLORS is highlighted. Rotate the SmartKnob™ to choose from the color palette.

Note: Color Palette 5 is designed for outdoor use and may not display correctly on some external monitors including the optional Heads Up Display (HUD). It is not recommended for this purpose. Colors have been optimized for display on the instrument. There may be color variations when displayed on external monitors.

LAYER	BACK-GROUND	SOFTKEY - TEXT	GRATI-CULE	FREQ. 1	FREQ. 2	ALARMS
0	BLACK	TEXT RED	GRAY	RED	YELLOW	YELLOW
1		TEXT GREEN	GRAY	GREEN	PINK	YELLOW
2		TEXT BLUE	GRAY	BLUE	LIGHT BLUE	WHITE
3		TEXT YELLOW	GRAY	RED	YELLOW	WHITE
4		TEXT GRAY	GRAY	WHITE	LIGHT BLUE	RED
5	WHITE	TEXT WHITE	BLACK			
6	BLACK	TEXT DARK RED	GRAY	DARK RED	RED	RED

DEFAULT INST.: DEFAULT INST. (Default Instrument) function restores the instrument to a known state before changing instrument parameters for a new test to assure that parameters are

a constant value. Default settings follow:

Parameter	Default Setting
Display	SWEEP OFF
Graticule	ON
Frequency	100 KHZ
Gain	40.0 dB, horizontal and vertical
Angle	0°
Position	50%, horizontal and vertical (middle of screen)
Filter	Low pass = 100 Hz; High pass = 0 Hz
Probe Drive	MID
Alarms	All alarms off
Sweep Alarm	Top threshold set to 75%, Bottom threshold set to 25%
Box Alarm	Top threshold set to 75%, Bottom threshold set to 25% Left threshold set to 25%, Right threshold set to 75%
Polar Alarm	Middle of screen, 25% radius
Dot Type	BOX
Radix point	Decimal
Report Header	Instrument Default

The load default will replace any parameter settings currently in the instrument with those listed above. It will not affect stored programs or stored data.

To perform the load default function, first press the SETUP function key, followed by the SPECIAL SETTINGS soft key, followed by the DEFAULT INST soft key. The instrument displays “PRESS LOG TO VERIFY”.

If you wish to load the default settings Press the LOG/ ENTER soft key. Pressing any other key or rotating the SmartKnob™ will abort this function.

UNLOCK FEATURES:

UNLOCK FEATURES allows certain functions of the various Nortec 500® instrument family to be “unlocked”. For example a model Nortec 500® instrument does not have the capability of operating a rotary scanner device such as the MiniMite™ scanner. For a nominal fee an “unlock code” can be purchased allowing the Nortec 500® to have this functionality.

For more information on this feature contact your local Olympus NDT representative. Contact information for your region maybe found by visiting the Olympus NDT web site at http://www.olympusndt.com/en/contact-us/

INST. VERSION: INST. VERSION (Instrument version or revision), feature displays the instrument configuration information. Occasionally when required by service technicians or Product Representatives this feature will help factory personnel identify your instrument to them and is provided for our customers to help meet their requirements and for future instrument expansion.

To access INST. VERSION (Instrument version or revision), press the SETUP function key, followed by the SPECIAL SETTINGS soft key followed by the INST. VERSION soft key. Once the INST. VERSION soft key is selected the impedance plain display will disappear and be replaced by text in the display similar to the example below.

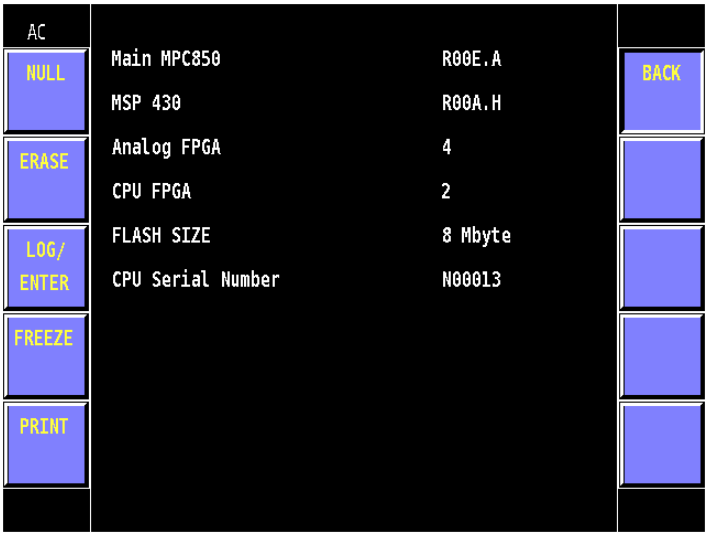


Figure 3.10

This information as well as the instrument serial number will be the information that factory personnel will use identify your instrument.

3.14 Special Functions

SCAN RPM: (Nortec 500 S and Nortec 500D Only) The SCAN RPM (Scanner RPM) function is used to set the RPM of the optional rotating scanner connected to the instrument. The instrument will automatically detect the type of scanner connected during PowerLink™, and set the range of RPM accordingly.

The RPM increments are dependent on the type of scanner attached. The Spitfire, MiniMite and RA2000 scanner are controlled in increments of 10 RPM; the PS-5 scanner is adjusted in increments of 1 RPM. The 19/RA scanner has a fixed speed of 1200 RPM and is NOT adjustable.

To change scanner RPM, select the SCAN function key, then press the RPM soft key. Once RPM is activated, the value may be changed by rotating the SmartKnob™.

SYNC ANGLE: (Nortec® 500 S and Nortec 500D Only) The Sync Angle function is used to adjust the display synchronization with respect to scanner position. If the flaw is displayed at the edge of the display in the external sync sweep mode, changing the sync angle to 180 degrees will move the flaw to the middle of the display.

To change Sync Angle, select the SCAN function key, and then press the SYNC ANG soft key. Once Sync Angle is activated, the value may be changed by rotating the SmartKnob™.

3.15 Waterfall Display Function (Nortec 500S and Nortec 500D Only)

The Waterfall Display Function is typically used in conjunction with a PS-5AL scanner. The term Waterfall is descriptive of the type of screen display that appears when this mode is used. It consists of a consecutive series of sweeps across the screen, each vertically offset slightly below the previous sweep. This display will only work when an optional scanner is connected to the N500 instrument. An example of a waterfall display with the scanner and eddy current

probe rotating in “air” is shown below in Figure 3.9.1.

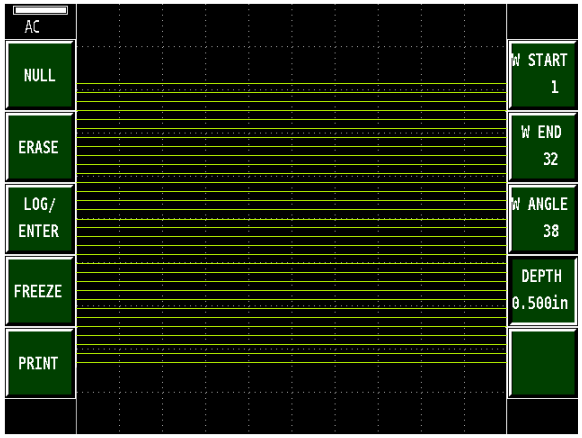


Figure 3.11 Waterfall Display

Each sweep represents one rotation of the scanner connected to the instrument, provided a sync pulse is supplied by the scanner in use. The number of sweeps is adjustable from a minimum of 4 to a maximum of 60 using the waterfall display function. The default value is 32 sweeps.

To select the Waterfall display function, press the SCAN function key, and then the SWP MODE (Sweep Mode) soft key. Once the SWP MODE soft key is selected rotate the SmartKnob™ until SWP MODE WATRFALL (Sweep Mode Waterfall) is selected.

To generate a waterfall display the ERASE soft key must be pressed and the scanner must be rotating. Note that the PS-5AL scanner and Nortec® 500 instrument both have an ERASE button. Press the ERASE buttons on either the PS-5AL or the ERASE key on the Nortec® 500 instrument to restart the waterfall display. A typical waterfall display with flaw generated from

a reference standard is shown in Figure 3.9.2 below.

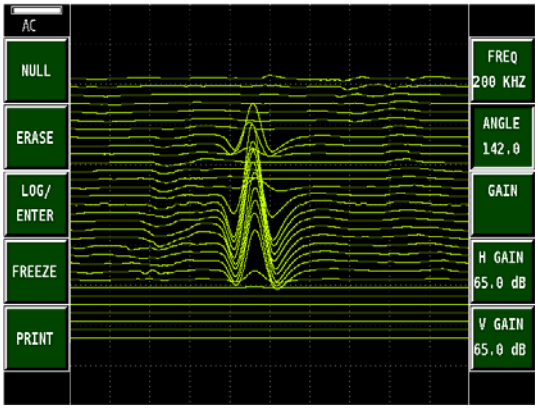


Figure 3.12 Waterfall Display

To change the Waterfall display, select the WATRFALL SETUP (Waterfall Setup) soft key. Once the WATRFALL SETUP soft key is activated the starting (W START) and ending sweeps (W END), waterfall angle (W ANGLE) and depth (DEPTH) can be controlled.

W START: (Nortec 500 S and Nortec 500D Only) The W START (Waterfall Start) function allows adjustment of the first sweep displayed during the waterfall scan.

To change W START, select the W START soft key. Once W START is activated, the value may be changed by rotating the SmartKnob™.

W END: (Nortec 500 S and Nortec 500D Only) The W END (Waterfall End) function allows adjustment of the last sweep displayed during the waterfall scan.

To change W END, select the W END soft key. Once W END is activated, the value may be changed by rotating the SmartKnob™.

W ANGLE: (Nortec 500 S and Nortec 500D Only) The W ANGLE (Waterfall Angle) allows the data captured in a waterfall display to be examined using XY coordinate display angles. Adjusting this value will redisplay the waterfall display with selected impedance plane angle.

To change W ANGLE, select the W ANGLE soft key. Once W ANGLE is activated, the value may be changed by rotating the SmartKnob™.

DEPTH: (Nortec 500 S and Nortec 500D Only) The Depth feature selects which Waterfall scan line is highlighted or displayed. For the PS-5AL scanner each rotation of the probe while indexing (translating) represents 0.025 inches of travel in or out of the hole. So adjusting the

depth control with the SmartKnob™ will highlight a selected scan line and list its depth from the starting point of the waterfall scan to the highlighted scan line.

To change DEPTH, select the DEPTH soft key. Once DEPTH is activated, the value may be changed by rotating the SmartKnob™.

Note: For data evaluation, the W ANGLE (Waterfall Angle) and DEPTH soft keys are used after the waterfall display has been generated (post processing). After highlighting one of these keys, pressing it again will cycle through displaying the whole waterfall scan, the highlighted scan by itself or displaying the highlighted scan as an impedance plane signal. Examples of this feature are shown in the examples below using data generated from Figure 3.9.2.

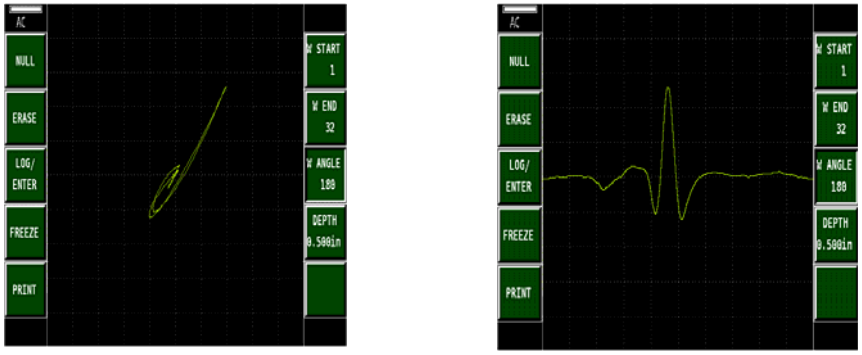


Figure 3.13 Impedance display (left) and external sweep display (right) of flaw at a depth of 0.500” in the reference standard

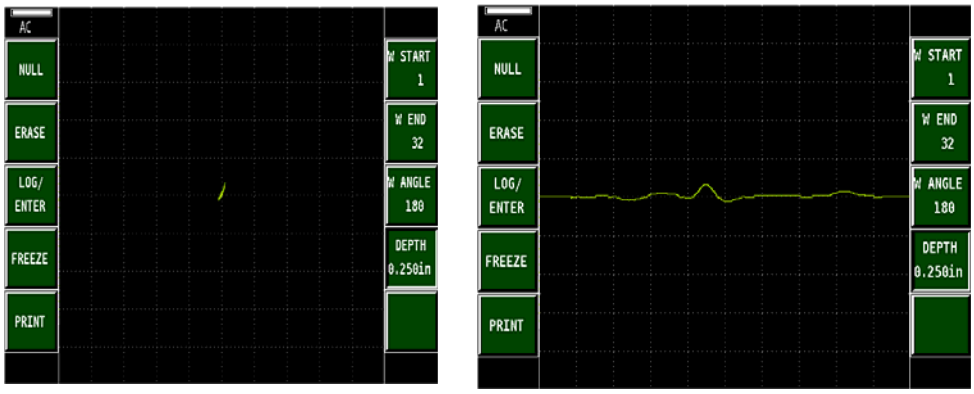


Figure 3.14 Impedance display (left) and external sweep display (right) of flaw at a depth of 0.250” in the reference standard

3.16 Conductivity Mode (Nortec 500S and Nortec 500D Only)

The Nortec® 500 instrument is capable of automatically detecting the existence of a Nortec® 16-pin Lemo 60kHz or 480kHz conductivity probe, and will reconfigure the operating parameters to allow for conductivity measurements. This operating mode will differ from the normal operating mode, in that there is no display of the eddy current signal.

Note: Only Nortec® branded conductivity probes allow this function.

The instrument can be made to display in either %IACS or MS/M. To change this setting first press the SETUP function key followed by the INST. PREFS (Instrument Preferences) soft key and the UNITS soft key. The default value is %IACS but can be changed to MS/M by rotating the SmartKnob™.

An eddy current instrument, such as the Nortec® 500 is highly sensitive to probe lift-off. This

is useful for reading the thickness of a non-conducting layer, such as a paint layer on top of a conducting metal.

Upon connection of a Nortec™ PowerLink™ conductivity probe, the following screen will be displayed. In this instance PowerLink™ program recognition and setup is automatic and there is no need to confirm the PowerLink™ program.

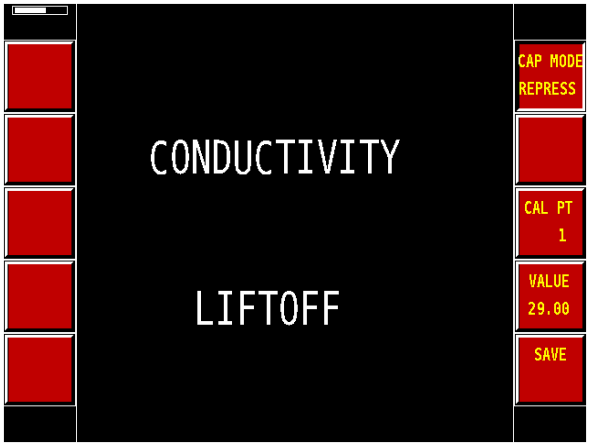


Figure 3.15 Conductivity Display

MAIN: The Main key provides access to the Conductivity Main menu, which allows the operator to perform a conductivity calibration. In addition, the Conductivity Main menu allows the operator to set the Nortec® 500 instrument for updating conductivity and liftoff data either continuously or when the capture key is pressed.

CAP MODE: The CAP MODE (Capture Mode) feature is for selecting conductivity and liftoff data continuously (CAP MODE CONTNOUS) or only when the key is pressed (CAP MODE REPRESS). When the conductivity instrument is set to “Repress” mode the instrument will hold the reading until the CAP MODE REPRESS soft key is pressed again and another reading taken. When the instrument is in “Continuous” mode the instrument will up date the reading every time the probe is in contact with the material under test.

To change CAP MODE, press the CAP MODE soft key. Once CAP MODE is highlighted, the value may be changed by rotating the SmartKnob™.

CAL PT: The CAL PT (Calibration Point) feature displays the calibration point that is currently being taken. If recalibration is desired, this feature should be set to 1 and then repeat the Calibration procedure. To change the CAL PT, press the CAL PT soft key. Once CAL PT is activated, the value may be changed by rotating the SmartKnob™.

VALUE: The VALUE (Calibration Value) feature allows for adjustment in order to match the conductivity of the calibration standard. To identify materials by their conductivity, reference standards will be required that have conductivities above and below the conductivity of interest.

The minimum and maximum values are set to the range. (±0.5% IACS [±0.3 MS/M] accuracy from 0.9% to 62% IACS [0.5 to 36 MS/M] and ±1.0% IACS [±0.6 MS/M] from 62% to 110% IACS [36 to 63.8 MS/M] — liftoff accuracy from 0 -15mil ±1mil). This must be set to the proper value before performing calibration. The conductivity value shown for CAL PT 1 is the conductivity for the lowest conductivity sample, and the conductivity value shown for CAL PT 2 is the conductivity for the highest conductivity sample.

To change the VALUE (Calibration Value), press the VALUE soft key. Once VALUE is highlighted, the value may be changed by rotating the SmartKnob™.

SAVE: The Save soft key (when highlighted and pressed) will store the calibration data for the calibration point shown in CAL PT. If this key is highlighted.

Conductivity Alarms: The Nortec® 500 has two alarms setups; the first alarm is the Conductivity Alarm and the second is the Liftoff Alarm. These alarms are only adjustable when a Nortec® conductivity probe is attached to the Nortec® 500.

To access the conductivity alarm menus press the ALARM function key while a conductivity probe is attached to the Nortec® 500.

3.16.1 Conductivity Calibration (Nortec 500S and Nortec 500D Only)

To calibrate conductivity:

1. Connect a Nortec® conductivity probe to access the conductivity function.
2. Set conductivity value for Cal Point 1. Press the VALUE soft key and rotate the Smart knob™ to change the VALUE (Calibration Value) to match the value of the lowest conductivity standard in the IACS range you are testing.
3. Set conductivity value for Cal Point 2. Press the VALUE soft key and rotate the Smart Knob™ to change the VALUE (Calibration Value) to match the value of the highest conductivity standard in the IACS range you are testing.
4. Press the CAL PT soft key and rotate the Smart Knob™ to change the CAL PT (Calibration Point) to “CAL PT” 1.

5. Place the conductivity probe on the reference sample (value of the lowest conductivity standard in the IACS range you are testing) and Press the SAVE soft key twice. “SAVING” will appear in the display window and the unit will then proceed to CAL PT2.

Note: It is normal for the N500 instrument to have a 2-3 second delay after pressing SAVE soft key (twice) in step 5 above. Do not move the conductivity probe until after the “SAVING” prompt has stopped displaying at the bottom of the instrument.

6. Place the conductivity probe on the reference sample (value of the highest conductivity standard in the %IACS range you are testing) and Press the SAVE soft key once. “SAVING” will appear in the display window and the unit will then proceed to CAL PT3.
7. Place a 4 mil (0.004”/0.1mm) non-conductive shim over the first sample (from CAL PT1). Place the probe on top of the shim and press the SAVE key once. “SAVING” will appear in the display window and the unit will then proceed to CAL PT4.
8. Place a 4 mil (0.004”/0.1mm) non-conductive shim over the second sample (from CAL PT2). Place the probe on top of the shim and press the SAVE key once. “SAVING” will appear in the display window.
9. CAL VALID” will appear on the top of the conductivity display. Conductivity readings may now be taken.
10. If the CAP MODE (Capture Mode) is in “REPRESS” mode the REPRESS soft key must be pressed to take a reading. To change to continuous readings Press the CAP MODE soft key and rotate the SmartKnob™ until “CAP MODE CONTNOU” is displayed.

3.16.2 Conductivity Alarm Menu (Nortec 500S and Nortec 500D Only)

LOWER: The Conductivity LOWER alarm limit is in %IACS or MS/M, which directly compares with the conductivity reading on the display.

To change the LOWER conductivity alarm, press the ALARM function key followed by the COND ALM SETUP (Conductivity Alarm Setup) soft key then the LOWER soft key. Once LOWER is activated, the value may be changed by rotating the SmartKnob™.

UPPER: The Conductivity UPPER alarm limit is in %IACS or MS/M, which directly compares with the conductivity reading on the display.

To change the UPPER conductivity alarm, press the ALARM function key followed by the COND ALM SETUP (Conductivity Alarm Setup) soft key then the UPPER soft key. Once

UPPER is activated, the value may be changed by rotating the SmartKnob™.

OFF / -/ +: The OFF / -/ + feature changes the alarm between positive polarity and negative polarity. Positive polarity forces the alarm to be ON when the liftoff or conductivity is inside the upper and lower limits set. Whereas, the negative polarity activates the alarm when the liftoff or conductivity is outside the set alarm threshold. OFF disables the alarm.

To change OFF / -/ +, select the ALARM function key, then press the “OFF / -/ +” soft key. Once “OFF / -/ +” is activated, the value may be changed by rotating the SmartKnob™.

3.16.3 Liftoff Alarm Menu (Nortec 500S and Nortec 500D Only)

LOWER: The Low Limit for the liftoff alarm is in mils (0.001”) or mm, this directly correlates with the liftoff reading on the display.

To change the LOWER liftoff alarm, select the ALARM function key then press the LIFT ALM SETUP (Liftoff Alarm Setup) soft key followed by the LOWER soft key. Once LOWER is activated, the value may be changed by rotating the SmartKnob™.

UPPER: The Upper Limit for the liftoff alarm is in mils (0.001”) or mm, this directly correlates with the liftoff reading on the display.

To change the UPPER liftoff alarm, select the ALARM function key then press the LIFT ALM SETUP (Liftoff Alarm Setup) soft key followed by the UPPER soft key. Once UPPER is activated, the value may be changed by rotating the SmartKnob™.

OFF / -/ +: The OFF / -/ + feature changes the alarm between positive polarity and negative polarity. Positive polarity forces the alarm to be ON when the liftoff or conductivity is inside the upper and lower limits set. Whereas, the negative polarity activates the alarm when the liftoff or conductivity is outside the set alarm threshold. OFF disables the alarm.

To change OFF / -/ +, select the ALARM function key, then press the “OFF / -/ +” soft key. Once “OFF / -/ +” is activated, the value may be changed by rotating the SmartKnob™.

3.17 PREAMP

The PREAMP (preamplifier) function provides an additional 5X gain (14dB) to the eddy current probe signal when activated. It is not recommended that this feature be used with High probe drive (PROB DRV).

To activate PREAMP, press the MAIN function key followed by the FILTER SETUP soft key then the PREAMP soft key. Rotating the SmartKnob™ turns the preamplifier on or off.

4. Applications

What's in this section?

- 4.1 Impedance Plane Display — Conductivity Curve
- 4.2 Surface Flaw Detection
- 4.3 Second Layer Crack Detection
- 4.4 Thickness Measurement
- 4.5 Conductivity - Sorting
- 4.6 Conductivity - Liftoff Measurement (Paint Layer Thickness Measurement)
- 4.7 Corrosion Detection with Dual Frequency
- 4.8 Scanner Operation
- 4.9 Waterfall Display Functions

The following probes and accessories are used in the Application section of this manual:

- Nortec SL/1 kHz-50 kHz/.31 PowerLink Surface Probe – P/N 9222161
- Nortec PL/500 kHz-1MHz/A PowerLink Surface Probe - P/N 9222162
- Nortec SPO-3806L Sliding/Reflection Probe - P/N 9222242
- Nortec SL/1 kHz-20 kHz/.62 Surface Probe - P/N 9222161
- Nortec Eddy Slide Rule - P/N 3306888
- Nortec Conductivity Samples (set of six) - P/N 1902474
- Nortec TB-S1 Crack Standard (.04", .02", and .008" deep notches) - P/N 1902510
- Nortec SPO-3932 Second Layer Crack Sample (1/16" Al on 1/16" Al) - P/N 1916915
- Nortec SPO-4304 Tapered Aluminum Standard - P/N 1916914
- CL/SC/6 Cable – P/N 9122083

4.1 Impedance Plane Display – Conductivity Curve

The following procedure is for impedance plane display-conductivity curve.

Equipment required:

- Nortec SL/1kHz-50 kHz/.31 PowerLink™ Surface Probe
- Nortec Conductivity Samples (set of six)
- CL/SC/6 Cable

1. Connect the probe. The PowerLink™ screen will appear. Press the LOG/ ENTER soft key to confirm. The screen will display information about the probe. Press the MAIN function key to proceed with the test setup.
2. Adjust the frequency to 25 kHz if necessary. Press FREQ1 soft key. Rotate the SmartKnob™ until 25 kHz appears in the FREQ1 box.
3. Adjust the phase angle to approximately 73°. Press the ANGLE soft key. Rotate the SmartKnob™ until 73° appears in the ANGLE box.
4. Adjust the gain to approximately 45.0dB. Press the GAIN soft key. Rotate the SmartKnob™ until 45.0dB appears in the H GAIN and V GAIN boxes.
5. Hold the probe in air, away from the conductivity sample, and press the NULL soft key.
6. Touch the probe to the middle of each of the six samples on the conductivity sample. The display should look like Figure 4.1. Some fine tuning may be necessary. This is accomplished by using the GAIN and ANGLE button and then the SmartKnob™.

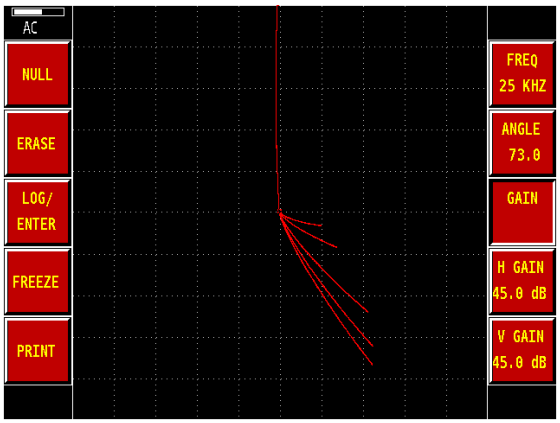


Figure 4.1 Conductivity Curve

4.2 Surface Flaw Detection

Equipment required:

- Nortec PL/100 kHz-500 kHz/A PowerLink™ Surface Probe
- Nortec TB-S1 EDM Standard, with .040", .020", and .008" deep notches
- CL/SC/6 Cable

Follow these steps for Surface Flaw Detection:

1. Connect the probe. The PowerLink™ screen will appear. Press the LOG/ ENTER soft key to Confirm. The screen will display information about the probe. Press the MAIN function key to proceed with the test setup.
2. Adjust the frequency to 200 kHz if necessary. Press the FREQ1 soft key. Rotate the SmartKnob™ until 200 kHz appears in the FREQ1 box.
3. Adjust the phase angle to approximately 78°. Press the ANGLE soft key. Rotate the SmartKnob™ until 78° appears in the ANGLE box.
4. Adjust the horizontal gain to 65.0dB and the vertical gain to 72.0dB. Press the H GAIN menu soft key. Rotate the SmartKnob™ until 65.0dB appears in the H GAIN box. Now, press the V GAIN menu soft key. Rotate the SmartKnob™ until 72.0dB appears in the V GAIN box.
5. Adjust the horizontal position to 80% and the vertical position to 40%. Press the DISP key followed by the SCREEN SETUP soft key. Press the H POS soft key. Rotate the SmartKnob™ arrow keys until 80% appears in the H POS box. Now, press the V POS soft key. Rotate the SmartKnob™ until 40% appears in the V POS box.
6. Place the probe on the TB-S1 crack standard away from the cracks and engraving. Press the NULL soft key.
7. Slide the probe smoothly over the three EDM notches. The response should look similar to those in Figure 4-2. These settings are only guidelines. Some fine tuning may be necessary. This is accomplished by using the GAIN and ANGLE button and then the SmartKnob™.

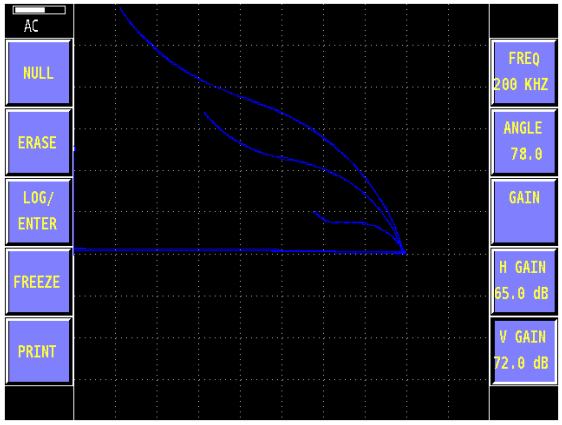


Figure 4.2 Surface Flaw Detection

4.3 Second Layer Crack Detection

Second layer crack detection is an eddy current inspection method used mainly by the aerospace industry. Ultrasonic inspections of any but the top layer are usually impossible because the interface between layers reflects ultrasonic energy preventing any usable penetration. However, these interfaces are practically invisible to eddy current devices applied normal to the surface of the layers. Therefore, when using eddy current the number of layers is insignificant, and the total depth of material is the only limiting factor.

Equipment required:

- Nortec SPO-3806L Sliding/Reflection Probe
- Nortec SPO-3932 Second Layer Crack Sample (1/16" Aluminum over 1/16" Aluminum)
- Detachable Cable-CL/SC/6

1. Connect the probe. The PowerLink™ screen will appear. Press the LOG/ENTER soft key to Confirm. The screen will display information about the probe. Press the MAIN function key to proceed with the test setup.
2. Adjust the frequency to 2.5 kHz if necessary. Press the FREQ1 soft key. Rotate the SmartKnob™ until 2.5 kHz appears in the FREQ1 box.
3. Adjust the phase angle to 260°. Press the ANGLE soft key. Rotate the SmartKnob™ until 260° appears in the ANGLE box.

4. Adjust the horizontal gain to 60dB and the vertical gain to 65dB. Press the H GAIN soft key. Rotate the SmartKnob™ until 60dB appears in the H GAIN box. Now, press the V GAIN soft key. Rotate the SmartKnob™ until 65dB appears in the V GAIN box.
5. Adjust the horizontal position to 75% and the vertical position to 15%. Press the DISP function key followed by the SCREEN SETUP soft key. Press the H POS soft key. Rotate the SmartKnob™ until 75.0% appears in the H POS box. Press the V POS soft key. Rotate the SmartKnob™ until 15% appears in the V POS box.
6. Turn OFF the screen graticule. Press the DISP function key followed by the D ERASE SETUP soft key, and then the GRATICUL (Graticule) soft key. Rotate the SmartKnob™ until OFF appears in the GRATICULE box. The display should look similar to Figure 4-3. These settings are only guidelines. Some fine tuning may be necessary. This may be accomplished using the GAIN, ANGLE, and SmartKnob™.

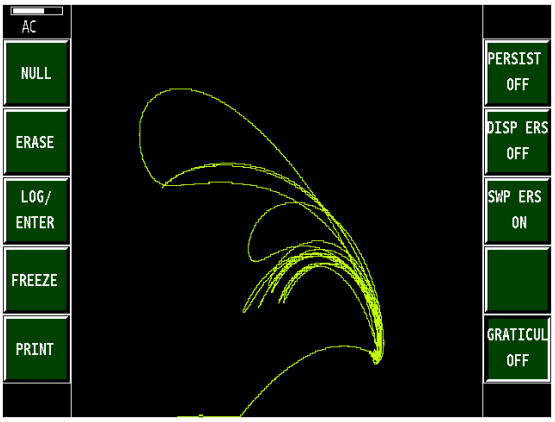


Figure 4.3 Second Layer Crack Detection

4.4 Thickness Measurement

Thickness measurements of nonferrous metals can be accomplished using eddy currents. It is important that a low enough frequency is selected to allow the eddy currents to penetrate the complete thickness being measured. The critical thickness for a given material and frequency is known as “one standard depth of penetration”.

This type of testing is most useful when trying to determine the remaining wall thickness as a result of internal corrosion.

Equipment required:

- Nortec SL/100Hz-20kHz/.62 Surface Probe
- Nortec SPO-4304 Tapered Aluminum Standard
- CL/SC/6 Cable
- Nortec Eddy Current Slide Rule

1. Connect the probe. The PowerLink™ screen will appear. Press the LOG/ENTER soft key to Confirm. The screen will display information about the probe. Press the MAIN function key to proceed with the test setup.
2. Adjust the frequency to 1 kHz. Press the FREQ1 soft key. Rotate the SmartKnob™ until 1 kHz appears in the FREQ1 box.
3. Adjust the phase angle to 41°. Press the ANGLE soft key. Rotate the SmartKnob™ until 41° appears in the ANGLE box.
4. Adjust the gain to approximately 58dB. Press the GAIN soft key. Rotate the SmartKnob™ until 58dB appears in the H GAIN and V GAIN boxes.
5. Adjust the horizontal position to 78.5% and the vertical position to 60%. Press the DISP function key followed by the SCREEN SETUP soft key. Press the H POS soft key. Rotate the SmartKnob™ until 78.5.0% appears in the H POS box. Press the V POS soft key. Rotate the SmartKnob™ until 60% appears in the V POS box.
6. Place the probe approximately 1.5" in from the thin end of the sample. Press the NULL soft key.
7. Place the probe at various locations representing different thicknesses. The display should look similar to Figure 4.4.1.
8. Carefully slide the probe down the entire length of the taper (this will produce the curve). The display should look similar to Figure 4-4-2.

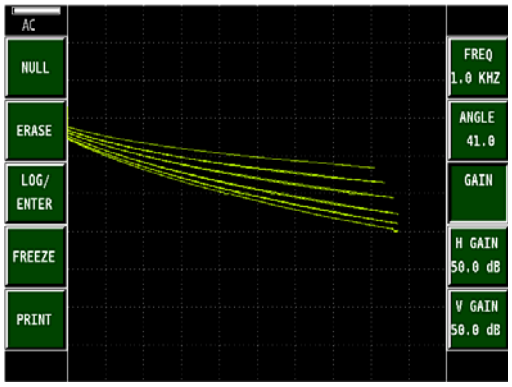


Figure 4.4.1 Thickness Measurement

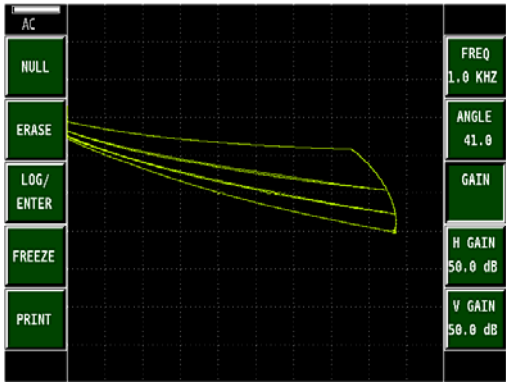


Figure 4.4.2 Thickness Measurement w/ curve

9. These settings are only guidelines. Some fine tuning may be necessary. This may be accomplished using the GAIN, ANGLE, and SmartKnob™.

4.5 Conductivity — Sorting

Equipment required:

- Nortec SL/1kHz-50kHz/.31 PowerLink™ Surface Probe
- Nortec Conductivity Standards - set of six
- CL/SC/6 Cable

1. Connect the probe. The PowerLink™ screen will appear. Press the LOG/ENTER soft key to Confirm. The screen will display information about the probe. Press the MAIN function key to proceed with the test setup.
2. Adjust the frequency to 50 kHz. Press the FREQ soft key. Rotate the SmartKnob™ until 50 kHz appears in the FREQ box.
3. Adjust the phase angle to 153.0°. Press the ANGLE soft key. Rotate the SmartKnob™ until 153.0° appears in the ANGLE box.
4. Adjust the horizontal gain to 60dB and the vertical gain to 68dB. Press the H GAIN soft key. Rotate the SmartKnob™ until 60dB appears in the H GAIN box. Now, press the V GAIN soft key. Rotate the SmartKnob™ until 68dB appears in the V GAIN box.
5. Adjust the horizontal position to 75.0%. Press the DISP function key followed by the SCREEN SETUP soft key. Press the H POS soft key. Rotate the SmartKnob™ until 75.0% appears in the H POS box.

6. Place the probe on the 7075-T6 sample and press the NULL soft key.
7. Place the probe on the MAG, and 7075-0 samples. The display should look similar to Figure 4-5.

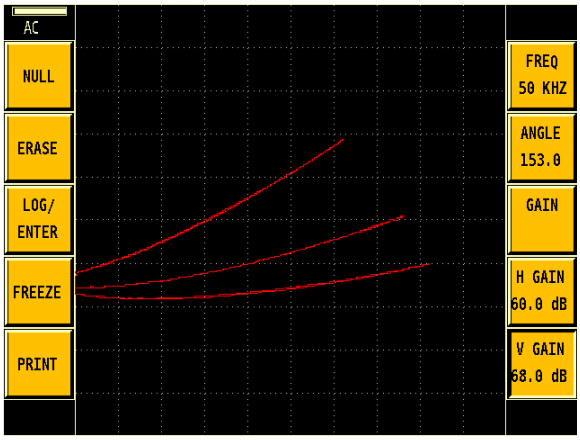


Figure 4.5 Conductivity Curve

These settings are only guidelines. Some fine tuning may be necessary. This may be accomplished using the GAIN, ANGLE, and SmartKnob™.

4.6 Conductivity — Liftoff Measurement (Paint Layer Thickness Measurement, Nortec 500S and Nortec 500D Only)

The conductivity/non-conductive liftoff feature of the Nortec® 500 can only be accessed by connecting a Nortec® conductivity probe.

Equipment required:

- Nortec 60kHz Conductivity probe with cable
- Nortec Conductivity Standards (certified % IACS)

Note: Recommended operating ranges: Best performance can be obtained by using the probes in the following ranges: 0.9% IACS to 20% IACS using a 480 kHz probe 9% IACS to 110% IACS using a 60 kHz probe. For best accuracy, the material to be measured should be at least one standard depth of penetration thick at the frequency of the probe used.

1. The Nortec® 500 should be calibrated before performing the lift-off measurement.
2. Connect a Nortec® conductivity probe to access the conductivity function.
3. Set conductivity value for CAL PT (Calibration Point) 1. Press the VALUE soft key and rotate the Smart knob™ to change the VALUE (Calibration Value) to match the value of the lowest conductivity standard in the IACS range you are testing.
4. Set conductivity value for CAL PT (Calibration Point) 2. Press the VALUE soft key and rotate the Smart knob™ to change the VALUE (Calibration Value) to match the value of the highest conductivity standard in the IACS range you are testing.
5. Press the CAL PT (Calibration Point) soft key and rotate the Smart Knob™ to change the calibration point to “CAL PT” 1.
6. Place the conductivity probe on the reference sample (value of the lowest conductivity standard in the IACS range you are testing) and press the SAVE soft key twice. “SAVING” will appear in the display window and the unit will then proceed to CAL PT2.

Note: Do not move the conductivity probe from the reference sample until the message “SAVING” is no longer displayed on the instrument.

7. Place the conductivity probe on the reference sample (value of the highest conductivity standard in the IACS range you are testing) and Press the SAVE soft key once. “SAVING” will appear in the display window and the unit will then proceed to CAL PT3.
8. Place a 4 mil (0.004”/0.1mm) non-conductive shim over the first sample (from CAL PT1). Place the probe on top of the shim and press the SAVE key. “SAVING” will appear in the display window and the unit will then proceed to CAL PT4.
9. Place a 4 mil (0.004”/0.1mm) non-conductive shim over the second sample (from CAL PT2). Place the probe on top of the shim and press the SAVE key. “SAVING” will appear in the display window. “CAL VALID” will appear on the top of the conductivity display window. The Nortec® 500 instrument and the probe can now be used to measure the

conductivity of the test material as well as the thickness of the non-conductive paint layer on the test material. (See Section 3.15, Conductivity Mode for complete operating instructions.)

10. If the CAP MODE (Capture Mode) is in “REPRESS” mode the CAP MODE REPRESS key must be pressed to take a reading. To change to continuous readings rotate the SmartKnob™ until “CAP MODE CONTNOU” (Capture Mode Continuous) is displayed.

4.7 Scanner Operation (Nortec 500S and Nortec 500D Only)

The Nortec® 500 will operate any of the following optional scanners: RA 2000, Spitfire 2000, PS-5AL, MiniMite, and 19/RA. Simply connect the scanner to the Nortec® 500, and the PowerLink™ feature will recognize the existence of the scanner. Press the LOG/ENTER soft key to confirm the default parameters associated with the scanner and then press the MAIN function key. The scanner will be in impedance mode. After preliminary adjustments are made to the flaw display signal, External Sweep must be turned on. Press the SCAN function key, then press the SWP MODE soft key three times to activate the external sweep.

The MiniMite scanner is variable speed, rotating at 600-3000 RPM, the Spitfire 2000 rotation speed is adjustable from 600-3000 RPM, the PS-5AL rotation speed is adjustable from 40-240 RPM, and the RA 2000 scanner rotation speed is adjustable from 600-2400 RPM (The 19/RA rotation speed is fixed at 1200 RPM). These five scanners are typically used for inspection of fastener holes.

The presentation of the scanner on the screen is a horizontal line. The line will be nearly flat when no flaws are detected. When a flaw is detected, the line shows a vertical displacement. The horizontal position of this indication shows the angular position of the flaw. The left side of the screen (zero degrees) corresponds to the top of the scanner (opposite from the cable exit or handle) while the middle of the screen (180 degrees) is toward the cable exit or handle.

When using the sweep display, only the vertical amplitude is displayed. Thus, the instrument rotation should normally be set for maximum displacement of the flaw in the vertical direction in the impedance plane before proceeding to the Sweep setting. However, it might also be a good idea to eliminate the noise in vertical displacement display by changing the angle until the noise signal on the impedance plane becomes horizontal.

Split Screen (External Sweep and Impedance mode) display can be used for setup. To do this, attach the scanner and confirm PowerLink™ setup. Press the SCAN function key then the SWP MODE soft key until “EXT/IMP” (External/Impedance) is displayed (The SmartKnob™ can also be used for this function). The split screen will then appear. On the left side of the display is external sweep, on the right the display is impedance plane. Any adjustment of angle

on the impedance plane display is linked to the external sweep display. To go back to full screen external sweep mode press the SWP MODE soft key until “SWP MODE EXTERN” is displayed or rotate the SmartKnob™ until “SWP MODE EXTERN” is displayed.

Note: When using “SWP MODE EXT/IMP” the impedance display (right screen) signal will not erase until (a) the ERASE soft key is pressed or (b) the DISP ERS (Display Erase) function is activated (see section 3.7, page 26 for more information on Display Erase function).

4.8 Waterfall Display Functions (Nortec 500S and Nortec 500D Only)

The Waterfall mode of operation is typically used in conjunction with the optional PS-5AL scanner. The PS-5AL scanner not only rotates the sensor head, but also gradually moves the sensor head in an axial direction. When the PS-5AL scanner is used in a fastener hole, the rotation provides a sweep of the hole at a certain depth and the vertical movement of the sensor head provides consecutive sweeps at different depths. These two movements combined provides 3-dimensional information of the flaws in the hole.

The term Waterfall is descriptive of the type of screen display that appears when this mode is used. This display consists of a consecutive series of sweeps across the screen. Each vertically offset slightly below the previous sweep. Each sweep represents one rotation* of the scanner connected to the instrument, initiated by a sync pulse supplied by the scanner in use. The number of sweeps is adjustable from a minimum of 4 to a maximum of 60 using the waterfall display function. The default value is 32 sweeps.

When a scanner with a fixed pitch is used, each sweep represents the forward movement of the probe into the test hole as determined by the pitch of the scanner. When a hand-held scanner is used, the sweep lines only represent the relative forward movement of the probe through a hole.

To start the waterfall display, press the ERASE button. The waterfall screen is then started and the instrument captures a new waterfall. The PS-5AL scanner has two buttons to remotely erase or null the display screen on the Nortec® 500. Any waterfall display may also be stored in the instrument memory for future use. Once stored, each display can be recalled and analyzed in either the waterfall mode, the impedance plane mode, or one line at a time in the sweep mode**. A sidebar adjacent to the screen display shows the parameters of the stored display including rotation angles, the maximum and minimum depth of the displayed lines, and

the depth of the selected line. Section 4.8, Scanner Operation should be read before using the Waterfall mode.

The following steps should be taken to setup the Nortec® 500 instrument for operation in the Waterfall mode:

The following steps should be taken to setup the Nortec® 500 instrument for operation in the Waterfall mode:

1. Insert a probe into the PS-5AL scanner, check for correct switch settings.

Probe	**Reference Coil Switch**	**Probe Type Switch**
Reflection Absolute	External	Reflection
Differential	External	Bridge
Reflection Differential	External	Reflection
3-Pin Absolute	External	Bridge
Absolute	Internal 1 or 2	Bridge
2-Pin Gulton	Internal 1 or 2	Bridge

Table 4.8.1 Switch Positions

2. With the instrument turned ON, connect the scanner cable to the scanner, and then connect the scanner cable to the PROBE (16 pin Lemo) connector on the Nortec 500 instrument.
3. The PowerLink™ function will automatically recognize the existence of the scanner and setup the parameters associated with the scanner. The settings are LPF 40, HPF 8, and RPM 240. Press the LOG/ENTER soft key to confirm the PowerLink™ function. Press the MAIN function key to display the impedance plane display.
4. Setting the operating frequency. Press the FREQ1 soft key and rotate the SmartKnob™ to the correct value. Set the scanner to rotate mode ON (see PS5 Scanner operations manual). Turn ON the power switch on the PS5AL scanner.
5. Place the scanner into a reference standard with the coil rotating over an EDM notch. A signal will appear on the display.
6. Press the ANGLE soft key and rotate the SmartKnob™ until the signal is vertical. To increase gain for maximum signal, press the GAIN soft key and rotate the SmartKnob™ until the maximum signal is achieved.

7. Turn ON the Sweep. Press the SCAN function key followed by the SWP MODE soft key. Press the SWP MODE soft key five times or rotate the SmartKnob™ until the display reads SWP MODE WATRFALL (Sweep Mode Waterfall) to activate Waterfall mode.
8. Press the WATRFALL (Waterfall) soft key to access the Waterfall menu. This menu allows the user to adjust the PS-5 scanner Waterfall Display. With the Waterfall Display now active, (for additional information see Section 3.15, Waterfall Display Function) the hole may now be scanned. Place the probe tip at the entrance to a hole. With the scanner running, pressing either the ERASE key on the instrument or scanner will start the waterfall display, set the scanner to translate mode ON (see PS5 Scanner operations manual) and the scanner will not only rotate but also translate and inspect the hole.

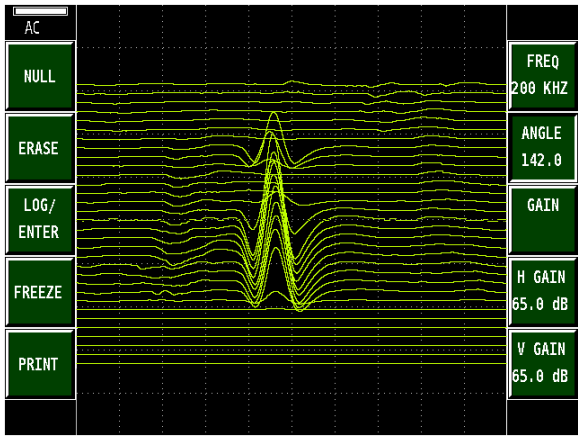


Figure 4.6 Sample Defect in a Hole Standard

Note: Care should be taken when operating a hand-held scanner in order to keep it from binding while being maneuvered in and out of the test hole. This will help prolong the life of the scanner and provide the most accurate Waterfall sweeps.

4.9 Corrosion Detection with Dual Frequency (Nortec 500D Only)

Equipment required:

- CL/SC/6 Cable

- SPO 5327L
- SPO 5851 Corrosion Standard

1. With the Nortec® 500 instrument turned ON and probe connected, press the SETUP function key followed by the INST. SETUP (Instrument Setup) soft key then the FRQ MODE soft key. Rotate the SmartKnob™ until the display reads “FRQ MODE DUAL FRQ” (Frequency Mode Dual Frequency).
2. Press the PRB DRV soft key and rotate the SmartKnob™ until it reads “PROB DRV HIGH”.
3. Press the MAIN function key followed by the FREQ1 soft key and rotate the SmartKnob™ until FREQ reads 3.0 kHz. Press the GAIN soft key and rotate the SmartKnob™ until the gain for both H GAIN and V GAIN are both 65.0 dB.
4. Press the MAIN function key followed by the FREQ2 soft key. Press FREQ2 soft key and rotate the SmartKnob™ until FREQ2 = 1.5 kHz. Press the GAIN2 soft key and rotate the SmartKnob™ until the gain for both H GAIN and V GAIN are both 65.0 dB.
5. Press the MAIN function key followed by the FILTER soft key. Set the Low Pass Filter to 30, by pressing the LOWPASS soft key and rotating the SmartKnob™ until LOWPASS reads 30.
6. Press the DISP function key followed by the 2ND DISP soft key. Rotate the SmartKnob™ until “SND DISP F2” is displayed. The display will change to “split screen” mode with frequency 1 displayed on the left screen and frequency 2 on the right screen.
7. Press the SCREEN SETUP soft key followed by the V POS soft key and rotate the SmartKnob™ until the V POS is 80.0%. Press the H POS soft key and rotate the SmartKnob™ until the H POS is 20.0%.
8. Place probe on the corrosion standard at Position 1 and press the NULL soft key. See Figure 4.7 below.

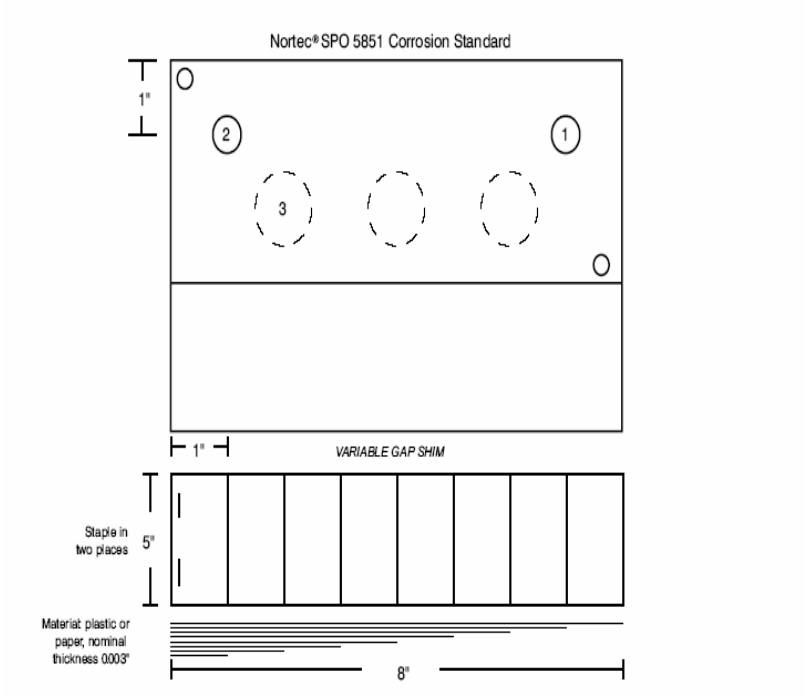


Figure 4.7 SPO-5851 Corrosion Standard

9. Slowly, lift probe off the standard and observe the signal. The Liftoff signal must be rotated to move from left to right.
10. Press MAIN function key followed by FREQ1 SETUP soft key. Press the ANGLE soft key and rotate the SmartKnob™ until the Liftoff signal moves from left to right in a horizontal direction. Press ERASE as necessary to clear the screen if necessary.
11. Place probe on standard at position 2 and increase the gain until the signal moves down (vertically) 6 divisions.
12. Place probe on Position 1 and press NULL key:
13. Place probe back on Position 2 and adjust GAIN so that the signal moves down (vertically) 6 divisions. If necessary, re-adjust the Angle so that the Liftoff line is horizontal.
14. Repeat this process for Frequency 2 until the screen is similar to Figure 4.8.

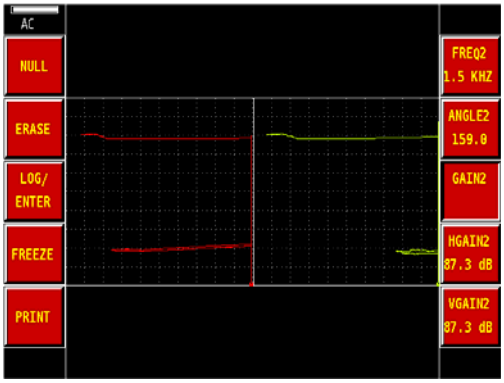


Figure 4.8

15. Once both frequencies have been set-up for position 1 and 2 it is a good idea to save this program before you proceed to the mix. Press the MEM soft key followed by the PROGRAM SETUP soft key. Rotate the SmartKnob™ until you are on a program location the reads “EMPTY”. Press the STORE soft key twice to store the settings. You may also wish to give this program a name for easy recall at a later time. To name the stored program press the NAME ITEM soft key. Using the “text editor” screen name the program and press the SAVE soft key twice.
16. Press the DISP soft key followed by the 2ND DISP soft key. Rotate the SmartKnob™ until “OFF” appears in the soft key window. The instrument will then return to the standard impedance display.
17. Press the MAIN DSP soft key and rotate the SmartKnob™ until “F1-F2” appears in the soft key window.
18. Press the SCREEN SETUP soft key followed by the H POS soft key and rotate the SmartKnob™ until the “H POS reads 80.0%. Press the V POS soft key and rotate the SmartKnob™ until V POS reads 20.0%. Press the MAIN function key followed by the FREQ1 soft key.
19. Place probe on Position 1 and press NULL soft key. Lift probe off the standard.
20. If signal moves to the right, decrease the FREQ1 Horizontal Gain until the signal moves to the left and is almost horizontal (see Figure 4.10.3).

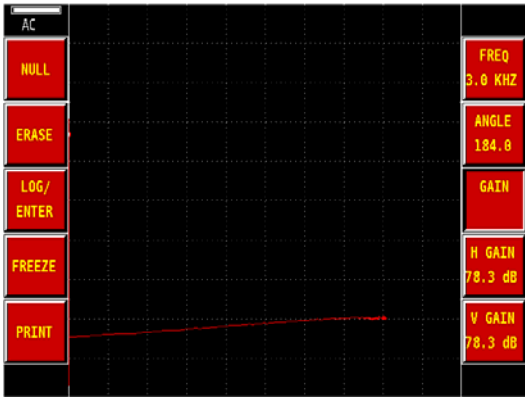


Figure 4.9

21. Place probe on position 1 and null the probe then place the probe on position 2 (see Figure 4.11).

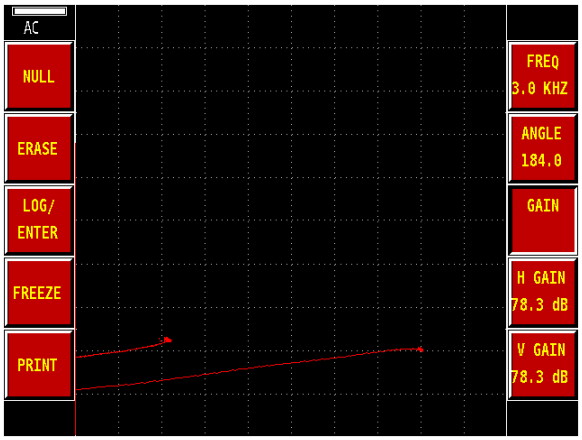


Figure 4.10

22. If the two null points are more than 3 divisions away horizontally, decrease the horizontal gain for Frequency 2 until it is 3 divisions from null point 1.
23. Place probe on Position 1 and press NULL key. Tilt probe and observe Liftoff line. If the signal moves from left to right, decrease the H GAIN for Frequency 1 until signal is almost horizontal from right to left. Slide probe to Position 2. This is the gap signal.
24. If the gap signal is below the Liftoff line, increase the Vertical Gain on Frequency 2.

25. If the gap signal is above the Liftoff line, decrease the Vertical Gain on Frequency 2.
26. Place the probe on Position 1 and press NULL key.
27. Place the probe on Position 1 and press NULL key.
28. Slide the probe down the center of the standard over the simulated corrosion and observe the signals.

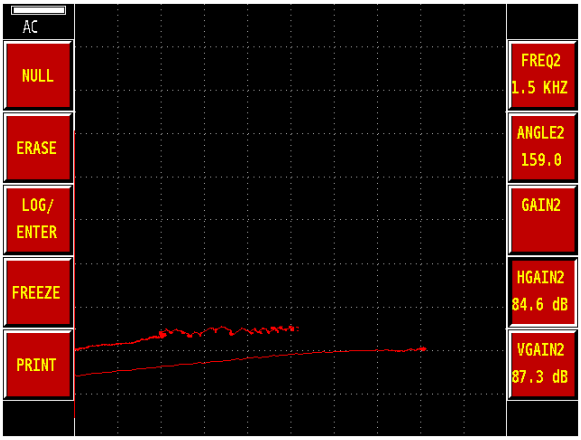


Figure 4.11

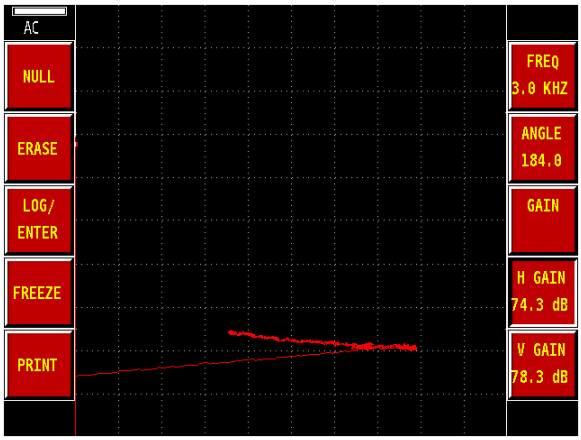


Figure 4.12

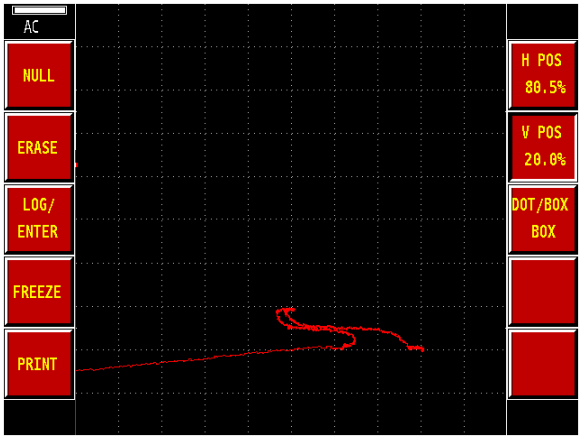


Figure 4.13a: Simulated 10% Corrosion Signal

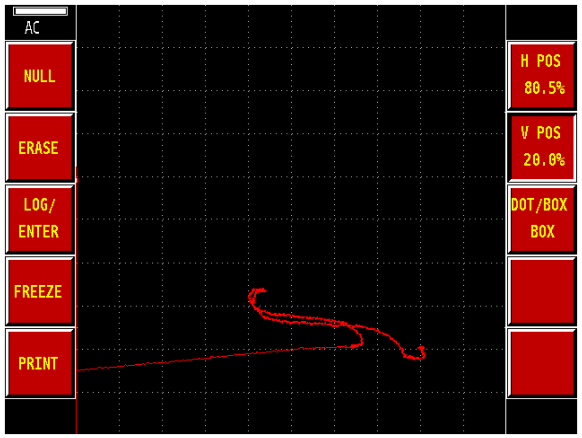


Figure 4.13b: Simulated 20% Corrosion Signal

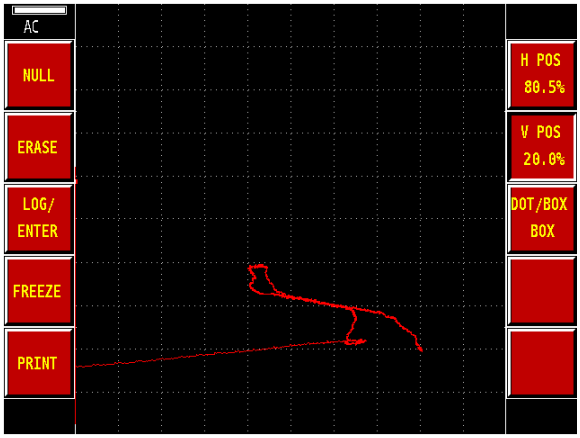


Figure 4.13c: Simulated 30% Corrosion Signal.

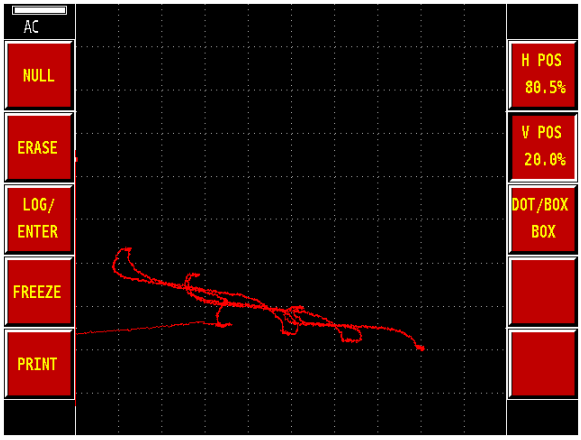


Figure 4.13d: Complete Scan of the Reference Standard

Appendix A: USB Communications

The Nortec® 500 can be controlled and monitored by an external computer. The USB communication port allows an external device to send commands to or obtain information from the Nortec® 500. Except for a few controls, operations available from the front panel are also available from the USB interface.

When monitored and controlled by an external computer, the USB port of the Nortec® 500 is configured as a peripheral. The Mini-B plug of the interface cable is connected to the Mini-AB receptacle on the Nortec® 500.

Note: Use of single and double quotes in this section is for the purpose of discussion only. The symbols delineate specific characters and character strings used in the USB interface and are not to be used in actual communications.

Commands Strings

Communication from external devices to the Nortec® 500 is performed using ASCII characters. A command string comprises three or more ASCII characters and a carriage return (terminator). The command string has three parts, not all of which are used in every case.

Parameter Specification	A three-character code that identifies the instrument item or function (see Command Specification Set).
Command Specification	A one-character code that identifies the operations as READ'?', WRITE'=', or EXECUTE (carriage return).
Parameter Value	The type and number of ASCII characters in this part of the command string is variable and depends on the parameter specification.

The Nortec® 500 recognizes three types of commands, READ, WRITE, and EXECUTE. The type of command is indicated by the command specification. To perform a READ operation, the '?' symbol is used. To perform a WRITE operation, the '=' symbol is used. To perform an EXECUTE operation, a carriage return is used.

The Nortec® 500 does not process a command string until a carriage return is received.

Status Reporting

After receiving a command, the Nortec® 500 checks for errors. If no error is detected, the operation is executed. On completion of error checking or command execution, the Nortec® 500 reports to the host with a prompt (prompts vary according to the results of error detection). Prompts are used by the host as indications that the Nortec® 500 is ready for another command. All responses are terminated by carraige returns and '>'.

Prompt	Description
"(carriage return)>"	Command Accepted
"C?" (carriage return)>"	Invalid Command
"V?" (carriage return)>"	Invalid Parameter Value

EddyMaster 500

EddyMaster 500 has an Issue Command feature located under File. From this window, any command may be issued.

Prompt	Description
"Instrument response received"	Command Accepted
"C?" (carriage return)>"	Invalid Command
"V?" (carriage return)>"	Invalid Parameter Value

Command Specification Set

Control of the Nortec® 500 is achieved using ASCII command strings terminated by carriage returns (0D [hex]). For commands that require ASCII letters (A-Z, a-z), either case may be used. Space (20 [hex]) are usually ignored but may be included in command strings (spaces may be included in the program or data names and print format strings). When specifying a real number value, the decimal point is required only when resolution beyond integers is desired.

Each instrument parameter permits a specific supset of the three command types (READ, WRITE, and EXECUTE). Command types permitted by each parameter are listed in the following table

CODE	FUNCTION	RWX	RANGE
MAIN			
FR1	Frequency 1	RW	.05 - 12000 (kHz)
AN1	Angle 1	RW	0.0 - 359.9 degress, 0.1, 0.5, 1.0 degree steps
GN1	Freqency 1 Gain	W	0.0 - 100.0 dB, 0.1 dB steps
HG1	Frequency 1 Horiz Gain	RW	0.0 - 100.0 dB, 0.1 dB steps
VG1	Frequency 1 Vertical Gain	RW	0.0 - 100.0 dB, 0.1 dB steps
FR2	Frequency 2	RW	1/2 (F1 < 6 MHz), 1/4 to 1/256
AN2	Angle 2	RW	0.0 - 359.9 degress, 0.1, 0.5, 1.0 degree steps
GN2	Freqency 2 Gain	W	0.0 - 100.0 dB, 0.1 dB steps
HG2	Frequency 2 Horiz Gain	RW	0.0 - 100.0 dB, 0.1 dB steps
VG2	Frequency 2 Vertical Gain	RW	0.0 - 100.0 dB, 0.1 dB steps
FHI	Frequency High Pass	RW	OFF, 2, 4, 6, 8, 9 - 100 in 1 Hz steps, 105 - 500 Hz in 5 Hz steps
FLO	Frequency Low Pass	RW	10 - 2000 Hz, FLO=2001 sets to Wideband, varying steps
CNL	Set Continuous Null	RW	"OFF, 0.2HZ, 0.5HZ, 1HZ"
PRE	Pre Amplifier	RW	"OFF, ON"
BLC	Balance Coils	RW	"1.2UH, 8.2UH, 15UH, 22UH, 47UH, 82UH, and 120UH"

CODE	FUNCTION	RWX	RANGE
MEMORY			
PRC	Program Recall	W	1 - 400
PST	Program Store	W	1 - 200
PER	Program Erase	W	1 - 200
PPR	Program Print	W	1 - 200 (only works with Bluetooth)
PGN	Program Name	RW	maximum of 29 characters
LPN	Last Filled Prgrm Location	R	1 - 200
PEF	Program Status	R	EMPTY, EC (Eddy Current)
PGL	Program Location	RW	1 - 400
PVN	Program Structure Version	R	
DRC	Data Recall	W	1 - 200
REF	Reference Memory	RW	OFF, 1 - 200
DER	Data Erase	W	1 - 200
DAP	Data Print	W	1 - 200 (only works with Bluetooth)
DAN	Data Name	RW	maximum of 29 characters
DAL	Data Location	RW	1 - 200
DEF	Data Status - Block	R	EMPTY, FIRST BLOCK, MIDDLE BLOCK, LAST BLOCK, UNKNOWN
DVN	Data Structure Version	R	
LDN	Last Filled Data Location	R	1 - 200
CLR	Defaults the Report	X	none
HDC	Clear Report Line Number	W	0 - 17
HDN	Report Line Number	RW	0 - 17
HDR	Report Line String	RW	maximum of 39 characters
CLP	Clear All Programs	X	
CLD	Clear All Data	X	

CODE	FUNCTION	RWX	RANGE
ALARMS			
B1T	Box 1 Top	RW	(B1B + 0.5) to 100.0%, 0.5% steps
B1B	Box 1 Bottom	RW	0.0 - (B1T - 0.5)%, 0.5% steps
B1L	Box 1 Left	RW	(B1L + 0.5) - 100.0%, 0.5% steps
B1R	Box 1 Right	RW	0.0 - (B1R - 0.5)%, 0.5% steps
B1E	Box 1 Polarity	RW	"OFF, NEGATIVE, POSITIVE"
POX	Polar X Position	RW	POR to (100% - POR), 0.5% steps
POY	Polar Y Position	RW	POR to (100% - POR), 0.5% steps
POR	Polar Radius	RW	0.5% to min(POX, POY, 100%-POX, 100%-POY), 0.5% steps
POE	Polar Polarity	RW	"OFF, NEGATIVE, POSITIVE"
SWT	Sweep Top	RW	(SWB + 0.5%) to 100%, 0.5% steps
SWB	Sweep Bottom	RW	0.0% to (SWT - 0.5%), 0.5% steps
SWE	Sweep Polarity	RW	"OFF, NEGATIVE, POSITIVE"
HRN	Alarm Horn Volume	RW	"OFF", 1, 2, 3
B2T	Box 2 Top	RW	(B2B + 0.5) to 100.0%, 0.5% steps
B2B	Box 2 Bottom	RW	0.0 - (B2T - 0.5)%, 0.5% steps
B2L	Box 2 Left	RW	(B2L + 0.5) - 100.0%, 0.5% steps
B2R	Box 2 Right	RW	0.0 - (B2R - 0.5)%, 0.5% steps
B2E	Box 2 Polarity	RW	"OFF, NEGATIVE, POSITIVE"
B3T	Box 2 Top	RW	(B3B + 0.5) to 100.0%, 0.5% steps
B3B	Box 2 Bottom	RW	0.0 - (B3T - 0.5)%, 0.5% steps
B3L	Box 2 Left	RW	(B3L + 0.5) - 100.0%, 0.5% steps
B3R	Box 2 Right	RW	0.0 - (B3R - 0.5)%, 0.5% steps
B3E	Box 3 Polarity	RW	"OFF, NEGATIVE, POSITIVE"
ADW	Alarm Dwell	RW	0.0 - 10.0 sec, 0.2 sec steps

DISPLAY			
HPO	Horizontal Position	RW	0.0 - 100.0%, 0.5% steps
VPO	Vertical Position	RW	0.0 - 100.0%, 0.5% steps
FDT	Cursor Type	RW	"DOT, BOX"
VAP	Variable Persistence	RW	OFF, 0.1 - 5.0 s for Single, 0.1 - 2.5 s for Dual Frq, 0.1 sec steps
CTE	Display Erase	RW	OFF, 0.1 - 60.0 sec, 0.1 sec steps
ASE	Sweep Erase	RW	"OFF, ON"
GRT	Graticule	RW	"OFF, ON"
MSD	Main Display (if in dual frq)	RW	"F1, F2, F1+F2, F1–F2"
SSD	Second Display (dual frq)	RW	"F1, F2, F1+F2, F1–F2"
TRK	Gain/Rotation Tracking	RW	"OFF, ON"

CODE	FUNCTION	RWX	RANGE
SCAN			
SWP	Sweep Mode	RW	"OFF, AUTO, AUTOXY, AUTOIMP, EXTERN, EXT/IMP, WATRFALL"
AST	Auto Sweep Time	RW	0.005 - 4.000 sec, 0.005 sec steps
RPM	Scanner RPM	RW	40 - 240, 5 RPM steps, 600 - 3000 RPM, 50 RPM steps
SCZ	Scanner Sync Angle	RW	0 - 359 degrees, 1 degree step
WMN	Waterfall First Sweep (Min)	RW	1 to (WMX - 3)
WMX	Waterfall Last Sweep (Max)	RW	(WMN + 3) to 60
WAN	Waterfall Angle	RW	0 - 359 degrees, 1 degree step (W ANGLE = WAN + AN1)
WHI	Waterfall Depth Indicator	RW	1 - 60 (WHI * 0.025 = DEPTH)

SETUP			
PDR	Probe Drive	RW	"LOW, MID, HIGH"
ANI	Angle Step Increment	RW	"0.1, 0.5, 1.0"
FSD	Frequency Mode	RW	"SINGLE, DUAL", "DUALFRQ" is acceptable for "DUAL"
MGN	Horizontal Mixer Gain	RW	"0dB, +6dB, +12dB"
VMG	Vertical Mixer Gain	RW	"0dB, +6dB, +12dB"
ADW	Alarm Dwell	RW	0.0 - 10.0 sec, 0.2 sec steps
HRN	Alarm Horn Volume	RW	"OFF", 1, 2, 3
DCM	Capture Mode	RW	"FREEZE, CAPONCE, CAPCONT"
CCT	Capture Time	RW	2.5 - 60.0 sec, 2.5 sec steps
RLK	Lock	RW	"OFF, ON"
LAN	Language	RW	"ENGLISH, FRENCH, GERMAN, SPANISH, ITALIAN"
SFM	Immediate Keys Position	RW	"LEFT, RIGHT"
AUE	Auto Erase After Null	RW	"OFF, ON"
PCM	Radix Point	RW	. (period), (comma)
MIN	Minutes	RW	0 - 59
HR	Hours	RW	0 - 23
DAY	Day	RW	1 - 31
MON	Month	RW	1 - 12
YR	Year	RW	1970 - 2104
TIM	Clock Time	R	Format is HH:MM:SS
SEC	Seconds	RW	0 - 59
DAT	Clock Date	R	Format is M/D/YYYY
CSH	LCD Color Selection	RW	0-6, increments of 1
LID	Load Default Instr. Settings	X	none
VER	Software Version	R	Format is RXXX.X
LOD	Load Default Operting Set	X	none

CODE	FUNCTION	RWX	RANGE
MAIN - CONDUCTIVITY			
CCM	Capture Mode (Cond)	RW	"ENTER, CONTNOUS"
CCP	Calibration Point	RW	1 - 4, increments of 1
CCV	Calibration Value	RW	For CCP = 1 or 2: %IACS: 0.90 - 110.00%, 0.01% steps (% not req on write) MS/M: 0.52 - 63.80, 0.01 MS/M steps
CCV	Calibration Value	R	For CCP = 3, same value as Cal Point 1 For CCP = 4, same value as Cal Point 2
MEMORY - CONDUCTIVITY			
LCF	Logger Location	RW	1 - 200
LCO	Columns	RW	1 - 500 (LCO X LRO ≤ 500)
LRO	Rows	RW	1 - 500 (LCO X LRO ≤ 500)
LTP	Type	RW	XY-ROW, XY-COL, PRINT, CLEAR
CLR	Defaults the Report	X	none
HDC	Clear Report Line Number	W	0 - 17
HDN	Report Line Number	RW	0 - 17
HDR	Report Line String	RW	maximum of 39 characters

ALARMS - CONDUCTIVITY			
CAU	Conductivity Alarm Upper	RW	(CAL + 0.1%) to 110.0 %, 0.1%IASC steps (CAL + 0.1) to 63.80 MS/M, 0.1 MS/M steps
CAL	Conductivity Alarm Lower	RW	0.9% to (CAU - 0.1%), 0.1% IACS steps 0.52 to (CAU - 0.1), 0.1 MS/M steps
CAE	Conductivity Al Polarity	RW	OFF, NEGATIVE, POSITIVE
LAU	Liftoff Alarm Upper	RW	(LAL + 0.1) to 25.0 mils, 0.1 mil steps (LAL + 0.01) to 0.64 mm, 0.01 mm steps
LAL	Liftoff Alarm Lower	RW	0.1 to (LAU - 0.1) mils, 0.1 mil steps 0.00 to (LAU - 0.01) mm, 0.01 mm steps
LAE	Liftoff Al Polarity	RW	OFF, NEGATIVE, POSITIVE
HRN	Alarm Horn Volume	RW	"OFF, 1, 2, 3, 4, 5, 6, 7"
SETUP - CONDUCTIVITY			
CNU	Conductivity Units	RW	"%IACS, MS/M"
LNU	Liftoff Units	RW	"MIL, MM"
LAN	Language	RW	"ENGLISH, FRENCH, GERMAN, SPANISH, ITALIAN"
PCM	Radix Point	RW	. (period), (comma)
MIN	Minutes	RW	0 - 59
HR	Hours	RW	0 - 23
DAY	Day	RW	1 - 31
MON	Month	RW	1 - 12
YR	Year	RW	1970 - 2104
TIM	Clock Time	R	Format is HH:MM:SS
SEC	Seconds	RW	0 - 59
DAT	Clock Date	R	Format is M/D/YYYY

CODE	FUNCTION	RWX	RANGE
KEY PRESSES			
IS1	Imm Exec Key 1 Keypress	X	none
IS2	Imm Exec Key 2 Keypress	X	none
IS3	Imm Exec Key 3 Keypress	X	none
IS4	Imm Exec Key 4 Keypress	X	none
IS5	Imm Exec Key 4 Keypress	X	(only works with Bluetooth)
MS1	Menu Key 1 Keypress	X	none
MS2	Menu Key 2 Keypress	X	none
MS3	Menu Key 3 Keypress	X	none
MS4	Menu Key 4 Keypress	X	none
MS5	Menu Key 5 Keypress	X	none
MS6	Menu Key 6 Keypress	X	none
KS1	Softkey 1 Keypress	X	none
KS2	Softkey 2 Keypress	X	none
KS3	Softkey 3 Keypress	X	none
KS4	Softkey 4 Keypress	X	none
KS5	Softkey 5 Keypress	X	none
KUA	Smartknob CW	X	none
KDA	Smartknob CCW	X	none
NUL	Nulls frequency 1 and 2	X	none
ERS	Erase Display	X	none
LOG	Stores Data	X	none
FRZ	Toggles Freezing Display	X	none

POWERLINK			
DSC	PowerLink Prb Description	R	
LNS	PowerLink Status	R	"NO, YES"
MPC	PowerLink Probe Classs	R	
MPD	PowerLink Probe Mode	R	
MPS	PowerLink Probe Serial #	R	
PTP	PowerLink Probe Type Str	R	

CODE	FUNCTION	RWX	RANGE
MISCELLANEOUS			
ALC	Alarm Status - Decimal	R	Bit 0 - Box 1, Bit 1 - Box 2, Bit 2 - Box 3 Bit 3 - Polar, Sweep, Conductivity, & Liftoff, Bit 4 - Or'd
AVA	Signal Average	R	-8183 to 8183 counts
BAT	Predicted Battery Capacity	R	0% - 100% (0% indicates no battery)
BMP	Bitmap of current display	X	none
CSK	Current Soft Key	R	0 - 4
CND	Conductivity	R	%IACS: 0.90 - 110.00%, 0.01% steps (% not req on wrte) MS/M: 0.52 - 63.80, 0.01 MS/M steps
ICP	Instrument Capabilities	R	NUL -> 0x00 (Empty String)
LFT	Liftoff	R	0.1 to 25.0 mils, 0.1 mil steps 0.01 to 0.64 mm, 0.01 mm steps
MCP	Module Capabilities	R	Conductivity 0x21, Scanner 0x22, Dual Frequency 0x24 (or'd)
NAM	Instrument Name	R	NORTEC500
PCF	Program XPC850	W	Address where program is to be loaded. Used internally with program Download.
PCX	Program XC2S150	W	Address where program is to be loaded. Used internally with program Download.
PKF	Program MSP430	W	Address where program is to be loaded. Used internally with program Download.
PRT	Printer Type	R	(only works with Bluetooth)
RDI	Instrument Battery Current	R	0.000 A - 2.000 A (0.000 A - no battery or fully charged)
RDV	Instrument Battery Voltage	R	0.000 V - 12.750 V (0.000 V indicates no battery)
NOTE: Ranges with " " indicate strings - the entire string must be entered. On ranges without " ", the trailing character(s) is optional: 1.5% or 1.5 are both acceptable			